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LIFE'S PLASTIC

Robert Edwards Rachel Kellett

Life in Plastic

The impact of plastics on India

By Robert Edwards and Rachel Kellett

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'I'm a barbie doll, in a barbie world.
Life in plastic - it's fantastic.'

From Barbie Girl, MCA Music, Scandinavia
1998

'We have divorced ourselves from the material of the earth, the rock, the wood, the iron ore. We looked to new materials which were cooked in vats, long complex derivatives of urine which we called plastics. They lacked the odor of the living. The result was a world in which all could live even if none could breath... Everywhere we are assaulted by the faceless plastic surfaces of everything that has been built in America since the war... Everything tends to look a little more alike and a little less like anything very definite.'

Norman Mailer, The Presidential Papers
1970

'Omnipresent, the plastic carry bag has strewn itself everywhere. In gardens, parks, drains, garbage dumps, on branches of trees and even in bird nests, it can be found to exist, propagating almost like a life form. Light and flimsy, the ubiquitous carry bag floats around in a light breeze, finding new places to litter and inhabit forever.'

Ravi Agarwal, New Delhi environmentalist
1996

Dedicated to the memory of Mahatma Gandhi

whoes message of striving for sustainability through self-reliance offers hope for humankind in the coming years.

Preface

This book grew out of three years living, working and travelling in India. During this time we saw two systems and ways of life existing side-by-side: the traditional and the modern, the clay kulhud and the plastic cup. We witnessed the arrival of plastic airline-type food on the Shatabdi express trains; from the windows we saw a landscape increasingly littered with plastic. In the cities we saw televisions, washing machines and refrigerators piled high in markets and the streets becoming clogged with new shiny cars, all filled with plastic parts. We saw the advent of internet cafes and plastic mobile phones. In rural areas, traders' stalls on festival days were filled with cheap plastics toys, bangles, buckets and bowls. Everything packaged in plastic carry-bags. People asked us what can we do about plastic litter? Can we safely recycle it? Can we burn it? What is it doing to us? We saw printed in the newspapers a lot of information and dis-information about the wonders and safety of plastic.

Originally this book was meant to be a technical report about PVC, the biggest selling plastic in India, a follow-up to the Greenpeace report 'The Stranger' (about the impact of chlorine chemistry in India). However, as we researched and studied plastic, its history and its impact, it became clear that we could not separate the environmental and human health effects of plastic from its cultural and economic context. Plastic is the material of the 20th century and its history mirrors the process of modernity that since 1991 the Indian Government has fully embraced. This apparently innocuous material is not socially neutral. It is not an indigenous species. It arrives in India with a set of values that promotes and exemplifies an economic system based on increasing material throughput. As a material it rejects and replaces renewable materials; as an industry it effectively devalues natural systems and shuns India's traditional ways of providing for material needs.

Three years is far too short a time to grasp the complexities and subtleties of life in India. We remain outsiders. While we are sometimes critical of aspects of government and industry in India, we have come to respect many people and ongoing social, political and environmental initiatives taking place. Through these people and their organisations we have learnt to question many of our own values and assumptions.

The authors

Robert Edwards is a documentary filmmaker and environmentalist. For 13 years, from 1986, he worked with Greenpeace International in the UK, Ireland, The Netherlands and France. He co-ordinated the Greenpeace North Sea Campaign and was the media strategist for the International Toxics Campaign. For the last three years he has worked in India, and in 1997 he wrote 'The Stranger', published by Greenpeace International, about the chlorine chemistry industry in India.

Rachel Kellett, an ex computer C-programmer, has been working in India for the past 3 years with Robert Edwards. She helped set up Toxics Link India, a network of environmentalists campaigning against toxic pollution.

Terms of reference

The terms north and south have been used throughout. The predominantly industralised countries are north of the equator (for example North America, Japan and Northern Europe). South of the equator the majority of countries (such as India) base their economies on rural, agricultural subsistence. Of course, many in the south live and aspire to northern values, while some in the north live as the majority do in the south.

North/south was chosen rather than east/west as east/west necessitates assuming a geographical poit from which to measure before establishing from which point east or west is measured. For example, what the north calls the Middle East is called West Asia by India. Other, essentially condescending, terms to describe this economic and cultural divide are 'developed' and 'underdeveloped' and 'first', 'second' and 'third' world.

Crore and lakh are Indian words for units of 10 million and 100 thousand.
1 crore - 10,000,000
1 lakh = 100,000

The US dollar conversion to Indian rupees is based on 1US$ = Rs40.

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Introduction

'Materials have played a pivotal role in human development and the appearance of certain materials has been so crucial that we have, for instance, named one of the bygone eras as 'Bronze Age'. There is no doubt that we now live in the 'Plastics Age', as plastics have made an epoch-making impact on our lives and we can literally dictate properties and have them.'

M. M. Sharma, Conference on Plastics and the Environment, New Delhi, 1994

Plastic is a material of the 20th century. It is the most versatile synthetic 'man-made' substance, created out of the fossil fuel resources that enabled most of the industrial and technological revolutions of the 19th and 20th centuries.

With the relatively recent arrival of plastics to India and the rapid growth of the industry over the last seven years, we are only now witnessing its impact on Indian society, culture, and landscape. Most visibly plastic bottles and bags litter both rural and urban India and are only partly dealt with by an army of destitute scavengers, euphemised as 'ragpickers'. In 1998 plastic bags clogged the drains of Bombay causing floods. In the last few years a number of large-scale fires erupted in Delhi markets where waste plastics are stored and sold causing an unknown number of human health problems from the release of highly toxic chemicals into the air. Autopsies on cows in the capital have found their stomachs stuffed

with as much as 110 pounds of plastics. The animals die a slow painful death from convulsions.

Less visibly, the plastics industry is inextricably linked with the 'liberalisation and globalisation' path the government of India is taking: the process of urbanisation, the creation of new consumer markets. The death knell for crores of jute farmers and other rural workers. Plastics encase, protect and enable modern technological revolutions. In agricultural regions, plastic drip irrigation systems and mulching facilitate the conversion of land from subsistence to cash crops. Plastic packaging enables the transportation of goods from local to global markets. Over 50% of plastics produced in India are used as non-biodegradable, disposable packaging – material that is created to be waste. Plastics are an integral part of consumer culture, in cars, home entertainment systems, and domestic appliances. In software-city, Bangalore, the new high-tech revolution of computers is encased in plastic – telecommunication wires, hardware, software and packaging. In hospitals medical equipment uses once-only plastics, sterilised and shrink-wrapped, plastic artificial joints, and heart valves. Life-saving equipment only made possible through the invention of plastics.

Some plastic products clearly mark a true innovation and provide vital services. But all plastics are problematic, environmentally and culturally, some more than others, and their effects are far-reaching.

➡ All plastics, except bio-plastics, are unsustainable since they use a finite resource, oil, as their base.

➡ All plastics, except most bio-plastics, involve the use of hazardous chemicals in their manufacture. Most at risk are workers in the industry and the community living near chemical plants.

➡ One plastic, PVC, is especially harmful to people and the environment throughout its life cycle, from manufacture and use through to disposal.

➡ All plastics, except some bio-plastics, do not easily biodegrade and all disposal methods pose problems. Most plastics are not effectively recycled unlike materials such as paper and glass, but are 'down cycled' into inferior products. The health of workers in plastic recycling is at

risk from chemical hazards created in melting plastics. Consumers are also at a risk from toxic additives.

➡ Many plastics, almost all of the 'commodity' plastics, replace traditional materials, which mostly use renewable resources in sustainable ways.

➡ Plastics add to the depletion of India's resources through substituting renewable materials with plastics.

➡ Most plastics are mass-produced to feed a consumer market and encourage new 'needs'.

This book concentrates on key products of the petrochemical industry, the so-called commodity plastics – polyethylene, polypropylene, polystyrene and polyvinyl chloride (PVC). Commodity plastics are among the plastics that cause the most environmental impact, through volume or hazardous content; they are the plastics that are replacing traditional materials in India; and they are the plastics that most visibly have helped to perpetuate a needy and ever hungry consumer society.

The Government of India's assumptions

India is in the process of rapidly expanding its production of plastic materials by several hundred percent, from 1 million tonnes per year to as much as 5 million tonnes. Such volume figures are not large, compared to the production output of the rest of the world[1], or the 43 million tonnes produced by North America alone. But this expansion of plastic production and products is having a significant impact both visibly and invisibly on the environment and society in India.

The expansion of the plastics industry in India is not happening by chance. The Government of India closely allied to industry has sanctioned and encouraged its growth. After Independence in 1947 India adopted a model of centralised socialist planning for all-round development. Even though the era of socialism has passed, the national economy in India is still being directed by a series of five-year plans. From the mid-1980s a number of government committees, dominated by the petrochemical industry and its academic and technical allies,

[1] Global production of plastic materials estimated by The British Plastics Federation in 1995/96 at 93,408,000 tonnes. Global production of bulk polymers estimated in 1995/6 at 60,643,000 tonnes

published reports promoting and justifying the expansion of the petrochemical industry and the need for its products.

The assumptions can be summarised thus:

- The plastics industry in the form of various products contributes to Indian economic growth by way of being a high growth industry. The export of plastic products is expected to substantially contribute to India's foreign exchange earnings.
- Expansion of the plastics industry will increase employment and skilled manpower.
- Plastic products are essential necessities and assist in providing the wherewithal for meeting basic human needs – food, clothing and shelter – as well as improving the quality of life.
- With the depletion of scarce natural resources plastics are the inevitable source of many material needs.
- Plastics are environmentally friendly. A key part being their lower energy content.
- India can effectively deal with plastic wastes through the informal recycling sector.

The first assumption that the petrochemical industry contributes significantly to greater economic activity is the key assumption and the reason why this industry is being treated as a 'thrust area for development' by the Indian government. The Indian petrochemical industry and its allies in the north have a more obvious agenda. They are motivated by the profit potential of the domestic Indian market. *It is a relatively untapped market, with a potential of one billion people and its annual consumption of plastics is one of the lowest in the world – 2.1 kg per capita per year as opposed to as much as 40-60kg in the north.* [1, Thakkar] The remaining five assumptions, as we shall see, are social justifiers for the economic arguments.

Progress through 'growth economics'

It is an implicit assumption of government planners that India needed to build its economy on the model of 'growth economics'. This model, like plastics, has its ancestry in the north. It was grounded in an ethical principle developed by the English philosopher, Jeremy Bentham, and

elaborated by John Stuart Mill in the 1830s. The goal was 'the greatest good for the greatest number' and necessitated an economic system that required growth to maintain it's own momentum. Born in the European Age of Enlightenment, the system materialised in the 18th century 'industrial revolution' in the UK, and spread to the rest of Europe, Japan and the US by the end of the nineteenth century. In the 20th century, economic growth necessitated a growth in material throughput, and consequent consumption of material resources. It found its cohesion in the continual search for material well being.

The south was first exposed to its mechanisms through the process of colonisation and by expropriation of its resources. Only in the last 50 years has the south independently embraced this economic system, encouraged by the institutions founded by the industrial powers at the Bretton Woods Conference in 1944 –The World Bank, The International Monetary Fund (IMF) and the General Agreement on Tariffs and Trade (GATT). The new economic world order, promoted by the victorious powers at the end of World War 2 (1939-1945) and led by the US, was floated on an *appropriation* of language.[2] It involved the creation of terms such as 'developed' and 'underdeveloped', 'first', 'second' and 'third' worlds, together with new definitions of poverty. 'In the 1950s a relative consensus among political and economic leaders in the North and the South took hold to the effect that economic well being should be considered an end in itself for the whole of humanity.' [2, Berthoud] A nations wealth, its material resources and productivity was henceforth to be measured as Gross National (or Domestic) Product (GNP or GDP). Values became reduced to numbers. Poverty was defined in simple monetary terms that marginalised and patronised many of the 'underdeveloped' civilisations of the south, including India's. The result is that today economic expansion based on constant technical innovation and material throughput is widely thought of as the only way to progress and to solve the world's economic problems.

Technology – the key to progress

'Greater production is the key to prosperity and peace', said US President Harry Truman in 1949. 'And the key to greater production is

[2] The UK's Shorter Oxford Dictionary definition of appropriation is the making of a thing private property, especially to take for one's own.

a wider and more vigorous application of modern science and technical knowledge.' Despite occasional critical voices, with Mahatma Gandhi as one of the weightiest, 'faith in scientific and technological progress spread like a universal new religion'. [3, Illich]

It was war, of course – the time-tested engine of invention and technology – that spurred the expansion of the plastics industry in the north. At the end of the war this new technology was re-deployed to manufacture consumer products that would contribute to general economic growth and the attainment of human well being. Through the mechanical momentum of the endless extruding machines, plastic products began to flood the northern markets and infringe on everyday life. Plastic became the material of choice replacing all that was found in its way. It cut competition on price because it was derived from a seemingly inexhaustible supply of oil. It was less solid and intractable than wood or steel. It was free of traditional preconceptions regarding its use and could be moulded into any shape a restless drive for novelty might conceive.

Above all, plastic was made by man, and liberated man from nature.

> 'Plastic's freedom to become anything will reduce everything to nothing by dissolving all differences. With plastic as a universal solvent, the hierarchy of substances is abolished: a single one replaces them all; the whole world can be plasticised.' [4, Barthes]

The innate flexibility of this new man made material together with its mass volumes potential enabled a totally new market concept to emerge that *the material would create the market*. Industrial chemists worked outwards from chemical discoveries to the marketplace. When they found something of interest they looked for ways to commercialise it. They were driven not so much by demand as by the pressure of market creation. At the end of World War 2 a Du Pont vice-president remarked:

> 'Satisfying desires for cars, washing machines, radios and other consumer goods would create an upward spiral productivity, raising the standard of living, increasing the national income, making more jobs.' But the vice-president feared that a 'satisfied people is a stagnant people'. After satisfying immediate desires, he said, merchandisers would have 'to see to it that Americans are never satisfied'. [5, McCoy]

Northern belief in science and technology gave rise to the perceived superiority of the north and the guarantee of the promise of development to the so-called 'Third World'. Jawaharlal Nehru, India's first Prime Minister, embraced the new scientific culture with enthusiasm. According to Nehru it was science and science alone that 'could solve the problems of hunger and poverty, of sanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people'. [6, Alvares] In India this heralded the 'green revolution' in agriculture and the introduction of mass-produced synthetic fibres such as polyester and rayon made from plastic polymers.

> 'Technology was viewed as offering a miracle of endless abundance through the substitution of plentiful materials for scarce ones. The replacement of silk, wool and cotton by synthetic fibres, and organic manure by chemical fertilisers, seemed to free society from the limited availability of land and its produce, and appear to make available unlimited resources of substitution.' [7, Shiva]

Whereas Nehru's vision was for India to develop its own science and technology, his daughter Indira Gandhi, her son, Rajiv Gandhi and subsequent governments gradually abandoned the state-controlled ideal in favour of 'free-markets'. Rajiv Gandhi, the grandson of Nehru and, like him, western educated, opened up India to the new 'market forces' and private enterprise in pursuit of economic growth. He gradually did away with his mother and grandfather's restrictive 'Licence Raj', and lowered import duties to encourage Indian companies to modernise technologically.

> 'We want every sector to grow. We want competition in the economy and at the same time we want to regulate the path of economic development. In fact, we are gearing to take-off.' V.P. Singh Finance Minister.

In the period 1989 to 1991 India started to fully emulate the northern, capitalist, free-market system through a series of measures to 'liberalise and globalise' its economy. In sanctioning the expansion of the plastic industry Indian government planners have fully embraced the language of industrial globalisation:

> 'The economic reforms have bought about the removal of capacity licensing by the Government of India, significant

> reduction of import barriers, easy access to import of capital goods, technology and raw materials. The benefit of reforms have percolated to the petrochemical industry and the economic activity in the country in general, be it in scale of operation, technology, cost effectiveness, funding instruments or increased international trade.' [9, GOI Mohan]

India's latest petrochemical processes are acquired through licensing agreements with foreign partners. Northern interests protect know-how and patents while India provides cheap labour and a huge potential market. The industrial elite in India is often educated in and by the US – industry's top managers are as much at home in Houston, Texas, as Mumbai. Like its northern counterparts, the strategy of India's premier petrochemical company, Reliance Industries Limited, is to create huge over-capacity of plastic production thus driving out competition by 'economies of scale' and by its ability to create markets.

India has gradually subscribed to the global economic networks. The Institutions created at the end of World War 2 have spurred a series of regional trade agreements. In North America, NAFTA; in Europe, the Maastricht Treaty; in South Asia, SAARC; in South East Asia, ASEAN; in the Pacific, APEC. The World Trade Organisation (WTO) is starting to dictate world-wide terms for global trading. 'All of these treaties seek to maximise international trade, to mould local economies world-wide to fit the shape of the industrial model, and to shift the locus of economic power from communities and local economies to the large corporations that now dominate the global economy.' [10, Gorelick] Daily, take-overs and amalgamations create larger but smaller numbers of corporations with greater global outreach. These are the organisations and agreements, and not the five-year plans of the Government of India, that will control the outreach of plastics in India, the imports, the exports, the creation of markets, impact the jute farmer in Bengal and the plastic recycling industry in Delhi.

Today Indian industrialists and some commentators embrace plastic technology with an enthusiasm reminiscent of the big expansion years of the northern industry in the 1950s. At an industry conference in 1994, chemistry academic M. M. Sharma proclaimed we are now live in the Plastic Age, echoing an American commentator from 1927:

'Materials have played a pivotal role in human development and the appearance of certain materials has been so crucial that we have, for instance, named one of the bygone eras as 'Bronze Age'. There is no doubt that we now live in the 'Plastics Age', as plastics have made an epoch-making impact on our lives and we can literally dictate properties and have them.

Plastics are the most wonderful substances and constitute a very important contribution of chemistry to the well being of mankind. Our daily lives would be much poorer without these benign and environmentally friendly materials which have a unique combination of properties which are often unbelievable by laity. Plastics can be super tough, rigid as well as flexible, transparent as well as opaque and can allow selective permeation or act as a barrier. We can even combine incompatible plastics and come out with blends and alloys that surpass the properties of the individual components... The ease with which the plastic can be processed into a variety of articles of everyday life, small and big, is truly remarkable and has no parallels.' [11, Sharma]

The great illusion of the epoch

After decades of using this man-made material, the cracks are appearing. After decades of this paradigm of development, fundamental fault lines are beginning to show. To take one Indian example, Bellary[3] remains one of the poorest areas in Karnataka. 'In its uneven pattern of development, Bellary district is a mini-India. In the biggest city, also called Bellary, there are small signs of a boom – three-star hotels, Internet cafés, the bounty from steel plants and a jeans factory. But in the villages nothing has changed – no clean drinking water, no roads, no electricity.' [12, Goldenberg] Why has 'development' failed for Bellary as it has for so much of India? Some will say that after only 50 years of (rapid) industrialisation India has come a long way. It just needs more time (and input/output of resources) to accomplish what the northern industrial revolution effected in 200 years. In time

[3] The national media spotlight was focused on Bellary after Sonia Gandhi chose it as the parliamentary seat from which to contest the national elections in September-October 1999. Congress controls all the levers of power in Bellary, from the hundreds of village councils to the 8 seats in the state legislature, and has always sent Congress MPs to the Lok Sabha in Delhi.

the 'trickle-down' from this development will meet the basic needs of her citizens as well as give India an effective position in the global marketplace.

Others, like novelist Arundhati Roy, see a conspiracy by the urban elite and the political masters of technocrats to destroy and exploit rural India.

> 'India lives in her villages, we're told in every sanctimonious speech. That's just another fig leaf from the government's bulging wardrobe. India doesn't life in her villages. India dies in her villages. India gets kicked around in her villages. India lives in her cities. India's villages live only to serve her cities. Her villagers are her citizens vassals and for that reason must be controlled and kept alive, but only just.'[13, Roy]

To an extent Bellary, exemplifies the problem with the current world-wide development paradigm. It has largely been a 'rational', linear and intellectual affair. We can control the soft landings of spacecraft on distant planets and put satellites into space. But we are unable to control the polluting fumes emanating from our cars and factories; to stop soil being denuded by inputs of chemical fertilisers; or to prevent water being polluted by industry and human wastes. The business world makes us believe that industries producing pet foods and plastic commodities are a sign of our high standards of living, while we cannot 'afford' to keep our water and air clean, or provide education and public transport for all. The world produces enough food to feed everyone, but many are starving or undernourished.

'Development' has failed because there are fundamental flaws in reliance on economic growth, and encouragement of material throughput. It has depended on the myth of the existence of unlimited resources; on the myth of an environment with an unlimited carrying capacity; on the myth of technological miracles; and on the lie of induced needs.

Resources are finite

The bottom-line for current methods of plastic manufacture is that its feedstock, oil, will be gone within a few generations.

Table 1: Depletion of resources, dates and desired reduction

Dimension	Sustainable level	Situation in 2040	Desired reduction	Scale of analysis
Depletion of fossil fuels				
Oil	Supply for 50 years	Supply exhausted	85%	Global
Natural gas	Supply for 50 years	Supply exhausted	70%	Global
Coal	Supply for 50 years	Supply exhausted	20%	Global
Depletion of metals				
Aluminium	Supply for 50 years	Supply remains	None	Global
Copper	Supply for 50 years	Supply exhausted	80%	Global
Uranium	Supply for 50 years	Depends on use of nuclear energy	Not quantifiable	Global
Depletion of renewable resources				
Biomass	20% terrestrial animal biomass 20% terrestrial primary production	50% terrestrial animal biomass 50% terrestrial primary production	60% 60%	Global
Species diversity	5 species/yr extinct	365-65,000 species/yr extinct	99%	Global
Polluting emissions				
CO2 emissions	2.6 billion tonnes carbon/yr	13 billion tonnes carbon/yr	80%	Global
Acid deposition	400 acid equiv/ha/yr	2,400-3,600 acid equiv/ha/yr	85%	Europe wide
Nutrient deposition	30kgphosphorous/hayr 267kg nitrogen/ha/yr	No quantitative data	Not quantifiable	Netherlands
Cadmium deposition	2 tonnes/yr	50 tonnes/yr	95%	Netherlands
Copper deposition	70 tonnes/yr	830 tonnes/yr	90%	Netherlands
Lead deposition	58 tonnes/yr	700 tonnes/yr	90%	Netherlands
Zinc deposition	215 tonnes/yr	5,190 tonnes/yr	95%	Netherlands
Soil Deterioration				
Due to dehydration	Status as in 1950	No quantitative data	Not quantifiable	Netherlands
Due to erosion	9.3 billion tonnes/yr	45-60 billion t/yr	85%	Global

Source: [16, Wetterings and Opschoor] 1992

In 1992 the Dutch Sustainable Technology Development Programme (STD) estimated how long key finite resources would last, together with the impact the continued use of these resources is having on our global environment (Table 1). The STD programme estimated that the global carbon (oil, coal and gas) resource would be exhausted by the middle of this, the 21st century. 'Humankind has inherited a 3.8 billion year store of natural capital. At present rates of use and degradation, there will be little left by the end of the 21st century.' [14, Hawken] However, advances in geological exploration and mining and drilling technology will no doubt extend the availability of oil. 'The carbon sitting in already discovered reserves stands at approximately one billion tonnes (including gas and coal). If yet to be discovered and unconventional fossil fuels are added, geologists estimate that another 3,000 billion tonnes of carbon lie under the earth's surface.' [15, Spencer]

The end of earth's carrying capacity

Well before 'advances in geological exploration' find new sources of precious oil, we will have created havoc with our climate and thus our ecosystems and health. The international environmental organisation Greenpeace, using the guidelines of the 1990 United Nations Advisory Group on Greenhouse Gases, analysed that we will break precautionary 'eco-limits' before we burn fewer than 225 billion tonnes of carbon, making major ecosystem damage very likely. 'Assuming that the world's forests do not become a major source of carbon (from clearing forests for agriculture), this carbon budget allows for less than 40 years of current fossil fuel use. Burning less than 5% of the planet's total fossil carbon can cause dangerous climate change.' [15, Spencer] As regards plastics, Swedish environmentalist Karl-Henrik Robert points out that, 'the industry sometimes argues that only 4-5% of the total oil production goes into plastic manufacture'. But adds, 'looking at the total amount of oil consumed, 4-5% is, in fact, quite a lot'. [17, Robert]

We are talking, as Schumacher so eloquently pointed out in 1973, about the cost of the earth's capital – its finite resources, its bio-diversity, clean water, and clean air. 'Every economist and businessman is familiar with the distinction (of income and capital), and applies it conscientiously and with considerable subtlety to all economic affairs – except where it really matters: namely the irreplaceable

capital which man has not made, but simply found, and without which he can do nothing.' [18, Schumacher] We are facing an historic juncture. For the first time the limits to increased prosperity are due to the lack, not of human-made capital, but rather of natural capital.

And we're talking about the 'cost' of human health effects and environmental damage from indiscriminate use of hazardous chemicals. Like so many other major industrial and infrastructure developments in India, the building of huge petrochemical complexes can lead to the loss of traditional lands and displacement of peoples. The toxic pollution arising from such complexes and the exposure of workers in the processing and recycling sectors is barely understood, let alone managed. Many of the chemicals routinely discharged by petrochemical facilities or burned in incinerators are persistent. Our children will carry this chemical body burden, passed from generation to generation. Some plastics, notably soft PVC, pose health threats to consumers – again our children will be most affected. The environmental impact of plastic waste, which is non-degradable and often hazardous, is unresolved and growing. In India it is barely controlled by an army of destitute scavengers known as ragpickers before being recycled, or rather 'downcycled', in hazardous back-street reprocessing operations.

Since India embraced the northern development model the evidence of environmental damage has grown visibly. The Tata Energy Research Institute (TERI) in its Green 2047 paper, (anticipating the consequences for the next 50 years), began its summary: 'While India has made substantial progress in most spheres of development over the last 50 years, the benefits of this growth have been substantially offset by environmental degradation'. While natural and social conditions (like growth in population and inequalities) do play an important role, man-made factors are important causes of degradation, summarised by TERI as 'industrial growth, urbanisation, and the spread of intensive agriculture which generate increasing wastes, all of which pollute India's rivers, air and land'. TERI estimates that by 2047, India will be 'water stressed', caused by the over-exploitation of groundwater, a consequence of the Green Revolution, coupled with water pollution from industry and solid waste. The petrochemical industry has had a part to play in this environmental degradation.

The state of India's environment

'The availability of renewable fresh water resources per capita in India fell from around 6,000 cubic metres per year in 1947 to about 2,300 cubic meters in 1997. It is estimated that by 2047, India will be 'water stressed' – per capital water availability will be as low as 1,600 cubic meters.... The spread of input-intensive agriculture has been at the cost of falling water tables, degrading soils, poor management of irrigation systems, and the harmful side effects of increasing pesticides and fertiliser use.

The municipal solid waste generated in India cities has grown from 60 lakh tonnes per year in 1947 to 480 lakh tonnes in 1997. Many of India's rivers, particularly near Delhi, Sharanpur, Kanpur, Ahmedabad, Kota and Varanasi, are in effect open drains, from the impact of untreated sewage and industrial wastes.

Currently, 10 crore tonnes of solid waste and 20 lakh tonnes of hazardous waste are generated by industry each year. The collection, transport, and disposal of waste is unscientific and chaotic. 'The water requirements of such major water-consuming industries as agro-based industries, refineries, petrochemicals, fertilisers and industrial chemical industries has grown from around 1,000 lakh litres per day in 1947 to around 40,000 lakh in 1997, and waste water increased from 700 lakh litres per day in 1947 to 30,000'.

Soil degradation is now widespread in India, affecting about 57% of the total land area of the country. 'The impact of nation-wide exposure to indoor and outdoor air pollution are enormous – 2.5 million premature deaths in 1997. In 34 cities an air quality index indicates that the quality varies from 'dangerous' to 'bad'.' [19, Tata Energy Research Institute]

Technology cannot save us

The bad news is that technology alone cannot save the planet or us. Dependence on technological innovation is still a blind alley pursued all too frequently by both the north and the south, regardless of whether it is sustainable or culturally acceptable.

> 'The northern, scientific tradition and rational ... has created, and maintained the prejudice that technology, whatever it is, is a good thing because it has been repeatedly asserted to be the only source of growth and therefore progress. The spread of new technologies therefore is 'good' and 'desirable'; answer to a question like, good for whom, is generally left for footnotes or somewhere in the inside pages.' [20, Diwan]

Even the oil crisis in the mid-1970s did not dent the optimism of the modernists. The theology of the market and the belief in technological miracles allowed contemporary economists like Robert Solow [4] to argue that 'the ancient concern about the depletion of natural resources no longer rests on any firm theoretical base'.

New technologies yet to be created are supposed to enable us to maintain the same level of prosperity as that facilitated by the old technologies, but now in an 'ecologically tolerable' form. All the things that were previously possible only by way of plunder of finite resources are now supposed to be conjured up as efficiently, as economically and above all, as abundantly as before. Belief in technology has effectively dismissed all existing natural processes and traditional techniques as inferior or of marginal value thus enabling big economically viable industry to substitute them with the straitjacket of industrial blueprints. [6, Alvares] Mass produced standardised plastic products are replacing India's ancient and modern knowledge of natural systems that use renewable materials in non-invasive sustainable ways.

Inequalities grow

It is not a system that benefits an increasing number of the people in the south who are being pushed from their lands by 'development projects' into urban slums. India has experienced widespread social

[4] Solow was even awarded the Nobel Prize for Economics for stating that production and growth can completely do away with the notion of exhaustible natural resources and that resource exhaustion is not a problem. [7, Shiva]

dislocation since embracing the paradigm of economic growth. The Tata Energy Research Institute (TERI) recently stated that, 'Recent estimates of the incidence of poverty contradict earlier estimates that suggested a substantial decline.' [19, Tata Energy Research Institute]

World-wide the poor are getting poorer: 'By the late 1970s it was obvious that, under the aegis of development most people became poorer as GNP grew.' [3, Illich] The trajectory of 'progress' has been mirrored by the countless negative indicators – including unemployment, the gap between rich and poor, homelessness, ethnic and racial conflict, wilderness loss, climate change and species extinction.

This global trend has led to the concentration of the world's markets and productive assets into the hands of a few firms. In 1995, 48 of the 100 largest economies in the world were in fact corporations and not nation states. In the US, the model for India's industrial elite, the rich get richer: 'Since the beginning of 1995, the (US) stock market has created more than five trillion dollars in new financial wealth and most of that money has gone to people who were already rich. According to Ed Wolf of New York University about 85% of the country's financial wealth is owned by the richest 10% of households. Luxury fever ... is not an independent ailment, but just one symptom of a much broader condition of the unbalanced and unequal nature of economic growth in modern America.' [21, Cassidy]

The inherently destructive mechanism of measuring progress through growth of material consumption is tolerated by the materially secure because growth is perceived (in principle) as the only means of creating increased material welfare for the world's population. No other system is currently thought viable by a global consensus of media, industry and political leaders.

Two polarities converging?

As the negative impact of industrial development became apparent in the late 20th century, those that argued and protested for the protection of the environment, including social justice and those that pushed for economic development became locked in opposition. One side saw the enormous benefits that the industrial economy provided. They claimed economic growth was crucial for our well being and wealth and technology will solve our problems and take us forward. They argued for increased economic activity to better the living condition of all and, by the way, pay for environmental protection. The other side argued that the pursuit of wealth thorough excessive consumption of finite materials was the root cause

The Northern Awakening

Since the 1970's there has been recognition that the earth cannot indefinitely sustain the prevailing notions and modes of development and progress. The UN Conference on the Human Environment held in Stockholm 1972 was the occasion on which the 'environment' arrived on the international agenda with acid rain, levels of pesticides and heavy metals in fish and birds. 'Countries discovered that they were not self-contained units, but contingent on actions taken by others. The Stockholm Conference was the prelude to a series of UN meetings throughout the 1970's that set to alter the post-war perception of an open global space where many nations can individually strive to maximise growth.' [23, Sachs]

The 1987 Brundtland Report said, 'We have in the past been concerned about the impacts of economic growth upon the environment. We are now forced to concern ourselves with the impacts of ecological stress – degradation of soils, water regimes, atmosphere and forests – upon our economic prospects.' The report famously defined sustainable development as a socio-economic system, 'that meets the needs of the present without compromising the ability of future generations to meet their own needs'. [24, WCED]

of environmental degradation and the destruction of cultures that can sustain economic activity. They argued for a reduced and more equitable resource flow. [22, Jackson]

As the environment became a mainstream political issue in the 1980s, both sides of the polarity agreed its preservation was important (if not vital). The first acknowledgement from the pro-industrial progress lobby came couched in 'economically sustainable terms'; cleaner production was economically viable, in fact it could be profitable. Yet this was clearly not enough to reverse growing environmental damage and continued over-exploitation of resources. Indeed environmental issues became just another marketing tool for the corporate world; a new set of images to use to sell more products.

The 'clarion call' for *reductionist* change came in the autumn of 1994 with the 'Carnoules Declaration'. Participants had come from Europe, the United States, England, Canada and India to the French village of Carnoules to discuss their belief that human activities were at risk from the ecological and social impact of materials and energy use. The Factor of Ten Club, as the group named itself, called for a leap in resource *productivity* to reverse the growing damage. 'Within one generation, nations can achieve a ten-fold increase in the efficiency with which they use energy, natural resources and other materials.' [14, Hawken]

Reduce By One Order Of Magnitude

'It is evident that the voyage to a fundamentally different technology may be long. If we take the examples of the commercial application of fuel cells, solar panels, photo-optic cables, fusion power or even television, we see a typical development process over 30 to 50 years. Decision-makers in government must consider their role in society in a new light. They must now consider how they can (continue to) fulfil the *needs* of society in their domain over the long term, while at the same time reducing the environmental impact *by at least one order of magnitude*.' [25, Van Grootveld]

Environmental organisations in the north such as UNEP, the OECD the WBCSD (World Business Council for Sustainable Development) and countries such as Austria and Sweden have endorsed the Factor of

Ten goals. Although there is some evidence that attempts are being made to use resources more effectively, and reduce material throughput, main stream political and industrial forces, including the oil industry, still pursue a business as usual agenda, and protect their vested interests.

Business as usual with the oil industry

If the oil industry were serious about helping reverse the process of climate change and preserve finite stocks it would commit massive investment to 'clean', renewable sources of energy. Yet while international oil companies such as Shell and British Petroleum (BP) profess concern over the impact on climate from their operations they plan to spend less than 0.4% of their turnover in one year developing renewable energy over the next five years. In 1997, the year the Kyoto Protocol on climate change was agreed, the oil industry spent an estimated $29 billion on adding to carbon stockpiles by seismic testing and wildcat drilling for new oil in areas outside existing reserves. [15, Spencer]

For 200 years the predominantly capitalist industrial economy has not valued but used without consideration our natural capital. We consume greater amounts of resources than we can replace. Some of our most valuable resources are finite and approaching extinction. We measure progress as growth in a singular monetary way irrespective of beneficial value, and with no value attached to our natural capital. A typical example is GNP, which measures money spent not value received. Growth includes all kinds of negative values, and as a system it encourages material throughput, rather than conservation of resources.

Fifty percent of the world's population has not yet embraced this value system. It has not yet been swallowed up by the industrial economy. This half of the human race – most of whom live in the villages of the south – is mostly ignored by policy makers in the north and political leaders in the south (except at election time). Ironically, many recent northern concepts and ways to reduce material throughput and to achieve so-called 'Sustainable Development' are embedded in southern cultures and have been for generations. Ecologists foresee the material future of humankind being based on the use of

renewable bio-materials by means of low-invasive technologies owned by self-sufficient village communities. These are the very cultures that are being marginalised and destroyed by the process of modernisation and globalisation.

In India as in many southern countries these two polarities exist side by side, the hunter/gathers and urban consumers, the clay kulhad and the plastic cup. However, the ever-growing numbers of Indians are in the process of turning their backs on the traditional way in favour the media-enhanced consumerism. 'Their exploding appetite for consumption and wasteful patterns of resource use, ensure that India is today in the midst of one resource crunch or another. This crisis is being translated into increasing social conflict, as different group's exercise competing claims on a dwindling resource base. India today is a veritable cauldron of social conflicts.' [26, Gadgil and Guha]

> 'A segment of the world's population will continue to live in tightly-encased enclaves of affluence and comfort while the majority is condemned to a brutish existence in ecological and economic wastelands. This scenario is already a stark reality for millions – whether in mega-cities like Delhi or thousands of resource-starved villages.' [27, Bakshi]

The policy makers tell us that slowing down or reversing the process of globalisation is 'unrealistic', 'unthinkable'. According to this view 'a fully globalised economy, dominated by Multi National Corporations (MNCs) is destiny; it is evolution; it is inevitable'. [10, Gorelick] Plastic is thought of an inevitable material of vital necessity; it is progress, it is new technology, it is impossible to think of life without it.

Blips and hangovers

If we could imagine the historical perspective from the end of the 21st century, we will hopefully look back at this – the era of hydrocarbons, of the profligate use of fossil fuels and the earth's finite resources, of technical revolutions and labour saving devices, of the pursuit of the 'good life' – as a mere 150 year blip in the history of the earth.

> 'Juxtaposed to the 10,000 years duration of the agrarian system, the industrial system appears as a brief, one-time paroxysm of intoxication in which the resources gathered over many millions of years are used up in a couple of hundred. This applies to fossil energy sources, but also to the concentrations of minerals, which are exploited and depleted, with the help of the former. There is much to suggest that this paroxysm will be followed by a bad hangover. [28, Ullrich]

Infinite growth through material exploitation has not always been the paradigm; it is a relatively recent philosophy.

> 'The historical movement of the West, under the flag of evolution/progress/growth/development, discovered and then prescribed needs. In this process, we can observe a transition from man the bungling toiler to main the needy addict. .... The attempt to satisfy the full spectrum of human needs through the production on consumption of goods has failed.' [3, Illich]

Our human condition, according to Illich, has become one of dependence on goods and services, a dependence that we call need. We have become 'Homo Miserabilis'. Imagine life without plastic? Too fantastic.

Meanwhile, as an example of how material consumption grips our daily life and defines our attachment to resource depletion, the global environmental crisis and the extent of our wants and needs, let us look at the amount of plastics that proliferate in our lives. This book was typed on a computer that is mostly made of plastic. In the process data was sent through high-tech plastic bound telephone wires. You might be reading by means of a plastic-moulded light. Plastic encased cables bring electricity to you. You probably live in a home with a metal refrigerator stuffed with plastic insulation and packaged products, watch cricket on a plastic television set, listen to polycarbonate CDs or audiocassettes and have a draw full of plastic bags that you meant to re-use. Your organic lotions, shampoo and 'spring water' are almost certainly packaged in plastic bottles, your milk in plastic pouches. You may walk the Himalayas in plastic soled boots, perhaps paid for with a plastic credit card. Read on.

Part 1
The Age of Hydrocarbons

1 What is plastic?

'Spurious, un-genuine, false, fake, sham, counterfeit, make-believe, mock, bogus, phoney, pseudo, so-called, cosmetic, not natural, artificial, simulated, man-made, paste, cultured, imitation, shoddy, rubbishy.'

Synonyms of 'plastic' from Roget's Thesaurus, 1992, Longman

The word 'plastic' comes from the Greek verb 'plassein', meaning to mould or shape a soft substance like clay or wax. Implicit in the Greek verb is the suggestion of permanence. In contrast the adjective from the Greek 'plastikos' suggests something capable of being moulded or shaped, something impermanent. Permanent or malleable, synthetic or natural, defining what plastics are has always been troublesome. Even today it is still unresolved whether they are imitators or improvers of nature, fixtures or ephemera. [29, Meikle]

An early plastic, celluloid, *imitated* the layering of ivory, the mottling of tortoiseshell, the hard translucency of amber and semiprecious gems, the weave and stitching of linen, the veining of marble. In the early 20th century plastics were promoted as *substitutes* for scarce natural materials – modern science was making replicas of luxury goods available to the common man and woman. Celluloid and newer plastics often seemed superior to natural materials, which had irregularities and flaws. Plastics became *improvers* of natural materials. They seemed miraculous "a new material under the sun' offering evidence of an ability to 'improve upon nature, even transcend it.' [30, Fortune]

For several decades at the end of the 19th century confusion reigned over just what exactly constituted a plastic. Among inventors, chemists and businessmen who promoted new materials, the noun referred to the manufacturing process. A plastic, whether natural or synthetic, was something that could be moulded or shaped when soft, and then hardened.

In 1903 the United States Patent Office made the classification 'plastics' out of the former 'Caoutchouc and Minor Plastics' classification. Although the new category explicitly excluded glass and butter, it admitted such oddities as 'scraps of cork, leather, etc' compressed to make 'articles of definite shape'. [31, United States Patent Office] Leo Baekland, considered 'the father' of synthetic plastics, boasted in 1909 that his Bakelite was 'far superior to all plastics'. It was 'a non-plastic' because its chemical composition rendered it permanently hard, infusible and insoluble.

Eventually a definition emerged that encompassed even Bakelite. The industries first trade journal, 'Plastics', borrowed a definition. Plastics (changed to plural to suggest a variety of types) were a 'commercial class of substances worked into shape for use by moulding or pressing when in a plastic condition'. As a category, plastics thus encompassed an array of materials united by similar manufacturing processes, shared markets and a common name.

Polymers

Today the range of plastic materials is based on a variety of 'polymers' of different chemical compounds and physical structures. The basic unit is the 'mer' or monomer and polymerisation is the process of stringing together of 'mers', usually in a line, like beads on a string.

Polymers are the basic building block of all plastics. They are compounds of carbon – synthesised from petroleum or natural gas – with one or more of the following elements: hydrogen, chlorine, oxygen, nitrogen or fluorine. A typical plastic molecule consists of hundreds or even thousands of carbon atoms, each surrounded by a complement of other atoms. This chain of atoms, although only minute fractions of a millimetre long, is a molecular giant. In spite of their size and complexity these giant molecules are relatively easy to assemble.

Scientists can shape the properties of plastics not only by choosing the monomers but also by controlling the way the building

blocks are arranged at the crucial moment when the monomers unite chemically to form polymers. Low-Density Polyethylene (LDPE), for example has a numerous array of side branches that trail off from the main carbon chains, acting as spacers to separate the molecules, thereby reducing their natural tendency to cling together. This polyethylene is therefore flexible and lightweight and softens at moderate heat.

For a polyethylene that withstands higher temperatures High Density Polyethylene (HDPE) was developed. Assembled with unbranched polymer chains, with no side chains to space them, these molecules pack more closely and cling together more tightly to make up a denser, less flexible plastic with greater heat resistance. Tougher still is a version with links between adjacent polymer chains. Made by drenching the plastic in high-energy radiation, these cross-links bind the molecules in a rigid matrix giving the familiar squeeze-bottle polyethylene enough durability for aerospace applications.

The words polymer and plastics have now almost become synonymous, but there is a distinction. Polymer is the 'pure' material. Often mixed with a variety of additives, polymers are capable of being extruded, injection moulded, calendered (rolled) and blown into sheets. Because they can be shaped or moulded they are, by definition, plastics.

Thermoset and Thermoplastic

Plastics are now broadly classified into thermoset and thermoplastics – the words themselves describe their process of manufacture. Modern chemistry has produced many other variations on these plastics, for example, polyurethane can be made either as a thermoset or a thermoplastic. The most well known thermosets are celluloid and Bakelite.

Thermoset plastic undergoes a chemical reaction during processing, which gives the resultant product its properties. The process is irreversible. They are made of resins from either phenol or formaldehyde or combinations of urea and formaldehyde or melamine and formaldehyde. They are then mixed with suitable fillers to give the properties required by the manufacturer of, for example, tableware, general mouldings, plugs, sockets and other electrical components. Thermosets are also used for the production of decorative and industrial laminates. Some thermoset materials are based upon epoxy

resins and unsaturated polyester resins. These are frequently reinforced with glass (glass reinforced plastics or GRP). Applications of GRP include the hulls of boats, cars and trucks, portable buildings, engineering components, household durables, window frames and the reinforcement of baths, large plastic pipes and fittings.

A recent family of thermosetting resins is the polyurethanes. Two chemical compounds are mixed and pumped directly into a means of shaping. The result can be either a solid or foam. Polyurethanes are used in the manufacture of furniture shells, upholstery, mattresses and thermal insulation.

Thermoplastics are processed by melting or softening and are converted to the shape required before they are cooled to give an object its various properties. The process is reversible and articles made from this type of plastics can theoretically be melted and reprocessed.

Thermoplastics now dominate world consumption of plastics. Mainly based on oil derivatives (usually ethylene), their manufacture is closely bound to the oil economy. They are usually manufactured in an integrated petrochemical complex that produces a range of different oil-base products and chemicals. Thermoplastics include the four main commodity plastics, the polyolefins, polyethylene (PE) and polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC). Other thermoplastics produced in lesser amounts include polyethylene terephthalate (PET) and Acrylonitrile Butadiene Styrene (ABS). There is also a range of thermoplastics used for special purposes, for example, plastics with resistance to higher stress levels, including Polycarbonate (PC). A whole new range of thermoplastics has now been developed to replace some of the commodity plastics. These include metallocene PE, copolyesters, made up of layers of different polymers and ethyl vinyl acetate (EVA).

Bio-plastics.

Bio-based plastics are made by taking the building blocks of the complex carbohydrates that plants are made of, and reconstructing (polymerising) them into plastics, either chemically, thermally or biologically using micro-organisms. Bio-plastics can be made from a number of renewable bio-based sources including starch, sugar, cellulose, proteins, oils and fats. Their advantage over petrochemical products is that they are derived from renewable and vastly abundant

resources. Their use does not make a net contribution to atmospheric carbon dioxide. By avoiding the use of additives the manufacture of bio-plastics does not generate hazardous toxic materials. Because they are biodegradable the production of intractable plastic waste is avoided.

It is important to distinguish these new developments in polymer technology from industry claims that conventional oil-based plastics are biodegradable. The first generation of bio-plastics was made from chemical modified PE or blends from PE and starch. (This technology was initially created to prevent wildlife, mainly birds, getting trapped in discarded plastic loops holding together beverage or beer cans - the so-called six-pack). While composting, only the starch broke down, leaving particles of non-biodegradable waste. These false bio-plastics have subsequently damaged the new bio-plastics market.

Overall uses of various plastics in India

Polypropylene (PP) The major market for PP in India is for sacking fertilisers, cement and powdered chemicals – presently challenging the traditional jute industry. It is also inject-moulded into containers, house-wares including crockery, schoolbags, briefcases, combs, furniture, toys, bottles, automotive components and disposable syringes. Film is widely used for packaging of soft goods, foodstuffs and textiles, domestic appliances such as hairdryers and electronic equipment. Fisherfolk use nets made of polypropylene.

Low Density Polyethylene (LDPE) has even wider applications. As film it is used for packaging foods, chemicals and fertilisers. Since it is an effective barrier to moisture it is used in damp proofing and linings of ponds and canals to prevent seepage. As a coating and laminate it is used to coat paper, milk and other food cartons and also for corrugated boxes for industrial purposes. LDPE pipes are used for water transportation, sewage disposal, the electrical industry and other uses as conduits.

The squeeze bottle is made by blow moulding LDPE. The ubiquitous plastic carry bag is also often manufactured from this thermoplastic. Many cables and wires use LDPE for insulation and transmission of low-voltage electricity. Linear Low Density Polyethylene (LLDPE) is a further refinement of LDPE and replacing it in some of applications.

Table 2 Glossary of plastic names (not comprehensive)

Class	Name	Common Acronyms
Natural Polymers	Horn	
	Gutta percha	
	Bois Durci	
	Shellac	
	Caoutchouc	
Bio-plastics	Thermoplastic starch	
	Cellulose acetates	
	Poly-3-hydroxyalkanoates	PHAs
	Polylactides	PLA
The semi-synthetics	Vulcanized rubber	
	Cellulose Nitrate	
	Cellulose Acetate	
	Casein Formaldehyde	
Thermosets	Bakelite	
	Phenolics	
	Epoxies	
	Polyurethane	PUR
	Polyester	
	Alkyds	
	Allylics	
	Melamines/Urea	
	Furan	
	Vinyl Esters	
Thermoplastics	Acrylic	PMMA
	Aramids	PI
	Acrylonitrile Butadiene Styrene	ABS
	Cellulosics	
	Ethylene Vinyl Acetate	EVA
	Fluoroplastics	PTFE, FEP
	Nylons (polyamides)	PA
	Acetal (polyacetal)	POM
	Polycarbonate	PC
	Polybutylene terephthalate	PBT
	* Polyethylene (high density)	HDPE
	* Polyethylene (low density)	LDPE/LLDPE
	* Polyethylene terephthalate	PET
	* Polypropylene	PP
	* Polystyrene	PS
	* Polystyrene (general purpose)	GPPS
	* Polystyrene (high impact)	HIPS
	Polysulphones	
	Polyphenylene Sulphide	
	Polyphenylene Oxide	PPO
	Styrene-Acrylonitrile	SAN
	*Polyvinyl chloride	PVC
	Polymethylpentene	
	Polyurethane (thermoplastic)	PU

* Commodity plastics

High Density Polyethylene (HDPE) is, as the name suggests, a denser more rigid form of polyethylene. Due to properties such as rigidity, resistance to high temperature and shattering it is used for a number of household items such as buckets, bowls, cups and plates. Toys made of HDPE are virtually unbreakable. Since it is practically odourless, tasteless and non-toxic it is often approved for use as packing for foodstuffs. Because of its stiffness and rigidity it is used to make crates and other containers for heavy goods and chemicals. Ropes and nets made of HDPE are superior to those made of LDPE. It can replace PVC in the majority of the PVC applications, especially for pipes.

Polyvinyl Chloride (PVC), the 'poison plastic' remains the biggest selling plastic in India with some 28% of the total plastics market. Table 3 shows the end use pattern.

Table 3 Indian PVC usage 1995

Sector:	%
PVC Construction	38
Agriculture	16
Communication/Power	14
Consumer	10
Footwear	10
Packaging	7
Transportation	3
Medical	2

Sources: NOCIL, March 1996

Engineering Thermoplastics (ETPs). Undeniably conventional materials do not always have the necessary thermodynamic properties to compete with thermoplastic polymers. This is particularly true in many 'high-tech' areas where products and technologies have evolved in synergy with the development of polymers. These plastics, often called Engineering Thermoplastics, proliferate in the latest technologies and products – cellular phones, CDs and CD ROMS, optic fibre cables, satellite TV, space and defence applications as well as automobile parts. The big four ETPs in India are:

- Polyamide (PA) (mainly nylons)
- Polycarbonate (PC)
- Polyacetal (POM)
- Polybutylene terephthalate (PBT)

ETPs materials – entirely made or as part of alloys, blends and composites – are used because they often display superior mechanical properties such as tensile and high impact strength compared to metals. Their heat performance is better at elevated levels. Some have good chemical resistance and good electrical properties. The fact that they are much lighter than conventional materials with the same or better performance means that they are used for aerospace applications, aircraft and some sectors of the transport and telecommunication industries.

Polystyrene, is mainly used for packaging and encasing. The largest market segment for polystyrene in India is audiocassettes. Table 4 gives the end use pattern.

Table 4 Current end use demand pattern for polystyrene

Market Segment	Demand in 1995-96 in tonnes
Cassettes	22,500
Refrigerators/Air-conditioner and coolers	15,400
TV	12,500
Audio/Radio cabinets	9,000
Packaging – disposable	7,000
Clocks	6,000
Miscellaneous (shavings, toys, lights etc)	6,450
Beads and bangles	5,400
Novelties, households	5,500
Stationery	4,600
Packaging – non disposable	3,650
Total	96,000

Source: Industry Estimates

Table 5 Commodity plastic use by sector

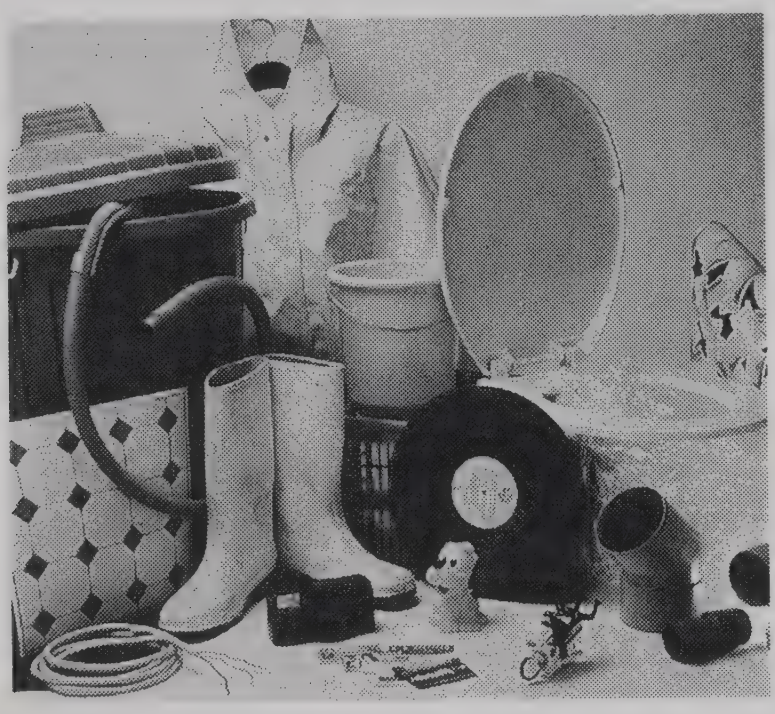
Sector		Polymers used
Packaging	Milk	LDPE film pouches
	Beverages	PET
	Beverage crates	HDPE, PP, PPCP
	Pharmaceuticals	PVC, HDPE, PP
	Squeeze tubes e.g. toothpaste	HDPE, LLDPE, PP
	Consumer goods e.g. soaps	LLDPE, LDPE, PVC
	Retail carrier bags	LLDE, HDPE,
	Pallet wrap	LDPE, LLDEP
	Fertiliser	HDPE/PP woven sacks
	Cement	HDPE/PP woven sacks
	Mineral	LDPE heavy duty
	Strappings	PP, HDPE
	Ropes	PP, Nylon
	Cushioning material	EPS, PU, PP, PE
Storage tanks	General	HDPE
	Water	LLDEP (rotomolded)
	Septic tanks	LLDPE, HDPE
	Agrochemicals	HDPE,
	Automotive fuel	HDPE, PP
Textiles	Textile apparels	PP, PET, Nylon, Acrylic
	Upholstery fabrics	PP, PVC rexene
	Carpets	PP, Nylon, Acrylic
	Furniture	PP, PPCP
	Textile cones & bobbins	PP, FRP
Consumer Goods	Toys	PP, ABS, HIPS, PVC
	Shoe sole	PVC, PP, structural foam, PU
	Luggage	PP, ABS, FRP, PPCP
	Buckets, tumblers	HDPE, LLDPE, PP
Construction	Pipes/tubings	PVC, HDPE, LDPE
	Window panes	Polycarbonate, Acrylic
	Window & door frames	PVC, FRP
	Sign boards	FRP, Acrylic, LD foam
	Appliance housings	ABS, FRP, PP, PPCP
	Plumbing fixtures	Polyacetals, ABS, PP

Sources: Economic Times 19 October 1993

2 A short history of plastics

'I just want to say one word to you, young man, just one word - plastics. There's a great future in plastics.'

From the US film 'The Graduate', 1968



It is forgivable to think that plastics are a relatively recent 'invention', a material of the 20th century. However, as part of the larger family of polymers they are a basic ingredient of plant and animal life. Today's cutting edge of plastics research lies in the development of bio-plastics made from naturally occurring starches and sugars.

The first natural plastics

The very first plastics were made from natural polymers. In the 17th century an Englishman, John Osborne, made mouldings from the natural polymer, horn. Later, gums from tropical trees were exploited, especially rubber and *gutta percha*. Gutta percha, from the milky sap of a Malayan evergreen, was used to insulate telegraph cables and to mould small consumer goods. *Shellac*, a resinous insect secretion gathered in India and South East Asia, was used with wood flour to mould cases for displaying early photographs. Shellac based compositions were used until the 1940's to mould gramophone records. Lepage worked in France with albumen (white of egg) and wood to produce his decorative *'Bois Durci'* plaques. Others worked with a variety of ingredients including seaweed, peat, paper and leather as additives.

The most profitable natural plastic was *caoutchouc* or rubber, derived from the Hevea Brasiliensis tree of South America. With his brother

Charles, Thomas Hancock refined the process of the *vulcanisation of rubber* (1839), independently discovered by Goodyear in the US. When vulcanised with sulphur, rubber became vulcanite, ebonite, or hard rubber and was used for buttons, fancy goods and electrical insulation. This was the first deliberate chemical modification of a natural polymer to produce a moulded material.

Casein Formaldehyde was created at the beginning of 20th century. Manufacture was based on fat-free milk to which rennin was added to form curds. When suitably dried, processed and coloured, it could be extruded into rods and made into sheets. The material was then hardened in a bath of formaldehyde from which it was machined into the desired end use. Brilliant colours and patterns made casein a desired material for making buttons, buckles, fountain pens, barrels and knitting needles.

Cellulose Nitrate, commonly known as celluloid, was the first plastic to achieve extensive commercial success but only after a decade or so of false starts and financial failures. Celluloid came from a mixture of nitrated cellulose (obtained from pulped paper or cotton) and camphor (from the bark of the Formosan camphor tree). Pressed into blocks under heat and pressure, it was sliced into thin sections and then, after being partially re-softened by heat, was cut, stamped, pressed or moulded into inexpensive consumer items, including dental plates for false teeth.

Englishman Alexander Parkes displayed his celluloid material at The Great International Exhibition in London in 1862 but the earliest example of marketing success was that of the Hyatt brothers in the US. They had been motivated in 1863 by a printer in New York who offered a prize of US$10,000 for an effective replacement for expensive ivory used to make billiard balls. They never succeeded in winning the prize but successfully marketed celluloid. *Substitution* and *imitation* were the goals of the nascent plastics industry. Celluloid succeeded because it became progressively less expensive than the tortoise shell, ivory, coral and amber that it imitated.

It was Du Pont, a US company, who paved the way for the use of plastics as a material in its own right. Du Pont's nitro-cellulose plants, active in the manufacture of explosives during the 1st World War (1914-18), sought peacetime applications. Through a policy of expansion that had started in 1910 Du Pont obtained exclusive licenses in a number of cellulose-based industries, as well as artificial leather (pyroxylin-coated fabric), artificial silk (viscose rayon),

cellophane film, and paints and lacquers. Du Pont emphasised celluloid's innovative potential as 'a chemical product which science has developed and perfected' or more grandly, a 'wonderful material, the product of American cotton fields and chemical plants'. [29, Meikle]

Cellulose nitrate had one great drawback, its flammability. In 1915 when Du Pont bought the major celluloid manufacturing facility in the US in Arlington, Virginia, it had a history of explosions, worker deaths and injury, destruction of plant and consequent rebuilding. Consumers also had to be wary – there were reports of an Ohio congressman whose celluloid visor caught fire as he tried to light a cigar, engulfing his head in flames. [32, New York World] *Cellulose acetate* was developed to meet this problem. Among its early uses were as 'safety film' and 'dope' to stiffen the wings of aeroplanes. It was initially fabricated like celluloid in the form of rod, sheet or tube but later became available as a moulding powder in various degrees of hardness, which could be quickly or economically shaped by injection moulding.

The first era of synthetic plastic belongs to the Belgian inventor, Leo H. Baekland. Aware of his goal from the beginning, the chemist expended years of research work to satisfy the world's desire for a material with 'properties found wanting in other materials'. Baekland wanted to call the result, a condensation product of the reaction between phenol and formaldehyde, oxybenzylmethyl-englycolanhydride, but mercifully settled for Bakelite. It could be moulded into any shape but became hard in its final phase. It resisted heat, electricity and harsh chemicals. Baekland himself described it in a 1926 promotional booklet entitled 'The Material of a Thousand Uses', as 'nearly immortal, possessing the ultimate degree of chemical stability'. This miraculous material not only substituted for inferior materials like shells, hard rubber, celluloid and porcelain, it also 'extended control over nature' by harnessing electricity for lighting, manufacture, transportation and communication. Baekland had presented humanity with a 'better material than any which nature unaided has provided'. The material that Baekland had 'invented' or 'discovered' in 1907 was a product of chemical synthesis, a substance distinct from its reactive parts, a substance with no direct analogue in nature; the first synthetic plastic.

Early growth of the plastic market

Plastic became a household material in the US and Europe during the years between the two World Wars (1918-39), an era when varied trends converged to form a consumer culture. The developing media industry, especially film, was indebted to plastic for its very existence. Advertising reached a public whose experience of the automobile, radio and movies disposed it to a universal identity based on mass-produced goods rather than regional or local tradition. Electrification triggered demands for domestic appliances on easy credit terms. Technical improvements merged with annual style changes to create a sense of unending material progress. Plastic, its form and colours proliferating as the consumer culture emerged into consciousness, embodied that culture and visually distinguished it as unique.

In 1927 publicists for the industry proclaimed a Plastic Age equal in historical significance to earlier ages of bronze, iron, gunpowder or steel – echoed by Indian chemistry academic M.M. Sharma at a conference in Delhi, 1994. In 1942, William Hayes, an economist and historian of the chemical industry declared that synthetic materials would have 'more effect on the lives of our great-great-grandchildren than Hitler or Mussolini'. He claimed further that these new materials could 'compel the course of history as greatly as any man'. [33, Plastics 3]

By 1940 many other substances had joined celluloid and Bakelite, each with unique qualities, to create a varied plastic spectrum. Colourful cast phenolic resins provided an alternative to Bakelite's industrial black or brown. Melamine resins were developed in the mid-1930s, offering the same range of colours and were more resistant to heat, water and detergents. In the UK plastics became socially acceptable when Queen Mary was publicised buying a plastic picnic set in 1931.

It was still a small industry. Although annual production increased tenfold in the US between 1921 and 1939, reaching 106,000 tonnes with a sales value of US$78 million, it totalled less than 1% of the total tonnage of steel.

Thermoplastics

During the 1930s oil-based thermoplastics were developed and started to appear in the market.

One of the firsts of the 'poly' era was *polyvinyl chloride* (PVC). Originally observed by chemists in the 1870s, it did not become a

commercial reality until suitable plasticisers were developed. Early PVC was rigid and struggled to find a market – one suggestion was as an adhesive (with rubber and cellulose derivatives) for sticking patches on worn clothes.

At the same time as PVC was being commercially developed in the 1930s, Du Pont launched the first polyamide – *Nylon 66* – perfected after a minute analysis of silk by their chemist, Wallace Carothers. A few months' later German researchers succeeded in producing the first Nylon 6 from caprolactam.

Another material with a lengthy gestation was *polystyrene*. Originally discovered by a German apothecary, Simon, another German, organic chemist Staudinger, realised that the solid that Simon had isolated from the natural resin was composed of long chains of styrene molecules. Commercial production still had to wait until 1937 before an economic way of preventing polymerisation during storage was found.

Despite these innovations, the stable, inert, and nearly immortal thermosets of Bakelite and other phenolic and urea resins, were by far the most prominent plastics up until World War 2 (1939-45).

Plastics go corporate

Just prior to World War 2 there was a fundamental shift in the way the new plastics came into existence. Figures such as Hyatt and Baekland sought to seek substitutes for specific materials. Small entrepreneurial companies focused on supplying a limited range of chemical materials ready for moulding or fabricating by others. The new generation of chemists, employed by emerging industrial conglomerates, worked outwards from chemical discoveries to the marketplace. When they found something of interest, they looked for ways to commercialise it. They were driven not so much by market demand as by the pressure of market creation.

This shift derived in part from the greater sophistication of chemists, who were beginning to devise general theories governing polymerisation of long-chained molecules. But owed as much to the rise of large vertically integrated chemical companies whose influence spanned many industries. In 1907 Baekland had thought nothing of starting out as an individual to develop a specific plastic based on a specific chemical process. By the late 1930s the push to exploit basic chemical raw materials that derived from coal, natural gas or oil, had

submerged such individual efforts. The development of new plastics occurred within a complex world of international corporate rivalries, parallel processes, cross licensing, informal exchanges of information among the industrial chemical fraternity and agreements that traded rights in one plastic for those in another. Nascent Multi National Companies (MNCs), Du Pont, Union Carbide in the US and ICI and IG Farben in Europe were starting to carve-up the new market. Baekland sold out to Union Carbide in 1939.

Yet while petrochemical giants were emerging and taking a grip on the production and market for the new materials, there was still room for the odd maverick inventor. Henry Ford, immortalised as the creator of the mass-produced car, had a vision of cars being built with plastics made from plants. In the 1930s he pre-empted the bio-plastic revolution by some 60 years, creating what was labelled by one newspaper 'part salad part automobile'. However, despite its robustness, the car was never put into production as US mobilisation for World War 2 intervened and the mass production of only tried and tested vehicles was accelerated.

The acceleration of war

It was the militarisation of Europe, Japan and later the US climaxing in World War 2 that spurred the development of the synthetics plastics industry. Natural materials became scarce as geo-political factors cut various countries off from traditional supplies. PVC was found to be an effective substitute for rubber, particularly cable insulation and sheathing. Nylons partly replaced wool and cottons. But it wasn't only substitution – new materials were needed with different properties, in particular for communications, aeroplanes and armour. UK's ICI Alkali Division produced *polyethylene* in 1935, a material whose properties were to become vital to the wartime development of radar. Another wartime ICI development was polymethyl methacrylate, more commonly called *acrylic* or *perspex*. First produced commercially in the UK in 1934, its shatter resistant properties were soon in demand for aircraft canopies and all kinds of protective screens. Annual production of plastics in the US nearly tripled between 1940 and 1945, a year in which about 370,000 tonnes went to such military uses as aircraft cockpit covers, mortar fuses, bayonet scabbards, helmet liners, and even the atom bomb.

Ford's bio-plastic car

Always a champion of the American farmer, Ford aimed at using agricultural products as raw materials and often claimed it would 'soon be possible to grow most of an automobile'. Sometime in the mid-1930s he converted a glass plant to the manufacture of a casein-type protein plastic with soybean meal as a base. The typical Ford car of 1936 contained ten to fifteen pounds of this soybean plastic in window frames, steering wheel, gearshift knob, horn button, accelerator pedal and electrical parts.

Early in November 1940 Ford invited a group of reporters to witness a demonstration of the plastic car's unique potential. He picked up an axe and swung it with all his might into the trunk panel of a custom-built car.

Rather than crumpling and losing its paint like an ordinary sheet-metal body, the back of the car rebounded back into shape as good as new because it was made of a tough phenol plastic with its black colouring imbedded throughout. Ford pointed in triumph to the undamaged trunk and announced that he would soon be mass-producing plastic bodied cars.

The first and only one appeared nine months later in August 1941 and was described by the St Louis Globe-Democrat as 'part salad and part automobile'. Before a crowd of ten thousand people, Ford unveiled an experimental car with a body of fourteen plastic panels attached to a tube-steel frame. The panels were compression-mould from hemp and ramie fibres embedded in a matrix of urea formaldehyde with wood and soybean flours. The car weighed only 2000 pounds, a third less than the standard sheet-metal sedan, and had acrylic windows. [29, Meikle]

Forced demand and expansion of the industry led manufacturers to greater understanding of plastics. To procure technically sophisticated equipment on a scale suitable for global warfare, governments had to acquire identical resins and interchangeable mouldings from many different material suppliers and processors. This necessitated regularising chemical definitions, physical specifications, and methods of testing for a potentially confusing, ever-increasing variety of plastics.

Mobilisation accelerated developments such as extrusion and injection moulding of polyethylene, low-pressure moulding of glass-reinforced polyester and vacuum forming of acrylic sheet. Material suppliers devised dozens of new formulations of older plastics like phenol formaldehyde and cellulose acetate.

The development of synthetic rubbers that took place during the war effectively crushed the natural rubber market. Cut-off from supplies of raw material in countries such as Malaya, Germany and Russia developed synthetic rubbers in order to be self-sufficient. In the US, production of a styrene-butadiene copolymer (GR-S later called SBR) went from zero in 1941 to over 700,000 tonnes in 1945. [34, Roderiguez] Although natural rubber regained some market share post-war, synthetics had gained the upper hand. One of the accomplishments of the SBR programme was the overnight conversion of many scientists and engineers into polymer engineers, chemists and physicists. After the war their interest remained in the field, so that the rather thin pre-war ranks of textile, rubber and paint researchers were suddenly swelled by a large number of highly trained people wedded to polymers and not to any one industrial application or product base.

Post war expansion: unfulfilled wants and desires

Plastics expanded exponentially after the war, with a greater growth curve than that of the GNP of the US. A few days before the nuclear explosions over Hiroshima and Nagasaki ended World War 2 in 1945, a gathering of market experts listened to J.W.McCoy, a Du Pont vice-president: business would be good for sometime owing to 'a great backlog of unfilled wants'. Satisfying desires for cars, washing machines, radios, and other consumer goods would create, 'an upward spiral of productivity, raising the standard of living, increasing the national income and making more jobs'. However, McCoy feared that a 'satisfied people is a stagnant people and after satisfying immediate desires, merchandisers would have to see to it that Americans are never satisfied'. [5, McCoy]

Most of the best plastics had gone into the war effort. By the time the troops came home the public was tired of shower heads made from cellulose acetate that softened in hot water, with laminates that separated when wet or stressed, with small mouldings

so devoid of resin that they shattered when dropped. Plastic's image took its first battering – on quality.

These were the formative years of the so-called 'baby-boomers', the generation born around the end of World War 2, an era of shoddy goods. Consumers expressed disdain for tacky raincoats and shower curtains made from improperly plasticised PVC sheeting. During the Christmas season of 1948, hundreds of consumers returned defective tree lights whose bulbs were hooded with thermoplastic birds, Santas and bells that had softened or became deformed or charred [35, Society of the Plastics Industry] The new thermoplastics were too unreliable compared to dependable celluloid or Bakelite. They lacked the latter's hardness and were sensitive in varying degrees to heat, chemicals, water and sunlight.

In response, the plastic industry sought to educate the post war generation, 'The right plastics for the right purpose'. [36, Modern Plastics] Through new advertising and PR tools, radio, print media, and TV, the plastic industry fought back with particular appeal to the new housewife, portraying plastics as squeaky clean and hygienic. Advertising proclaimed the era of 'Easy Upkeep'. Where every plastic surface could be kept sparkling clean by merely the wipe of a damp cloth. [37, House Beautiful]

As plastic utopians had predicted, synthetic material invaded the US home after the war, and in the guise of traditional materials. PVC masqueraded as ceramic and leather in floor tiles and upholstery, as wood grain in laminate walls and formica tabletops. Baby boomers played with Wham-O hula-hoops and frisbees, Barbie dolls and Revel airline models, Lego blocks and Mattel machine guns. Kids ate breakfast from formica dinettes, spilled milk from polyethylene tumblers onto PVC floors, and left for school hauling their leatherette satchels, clutching Bic biros. For the family, there was tupperware, garbage bins, and laundry baskets, melamine dishes, appliance housings, cling film and dry cleaning bags, picnic coolers, scuff-proof luggage, Naugahyde furniture, Mylar recording tape, Corfam shoes, shrink-wrapped meats, Styrofoam egg cartons, artificial Christmas trees. Even life's greatest status symbol, the automobile, took on more plastic each year – that desirable new car smell came from (probably) poisonous plasticisers migrating into the air.

Europe displayed a similar enthusiasm. In 1957 French philosopher, Roland Barthes, visited a plastic trade show in Paris and was inspired

by the sight of perfectly formed plastic consumer products emerging from an injection-moulding machine. 'Despite having the name of Greek shepherds (Polystyrene, Polyvinyl and Polystyrene) plastic is in essence the stuff of alchemy'. The sight of each form (suitcase, brush, car-body, toy, fabric, tube, basin or paper) emerging from the machine was like a miracle, a transformation of nature.

> 'The quick-change artistry of plastic is absolute: it can become buckets as well as jewels. Hence a perpetual amazement, the wonder of man at the proliferating forms of matter, and the connections he makes between the singular of the origin and the plural of the effects. And this amazement is a pleasurable one, since the scope of the transformations gives man the measure of his power, and the very journey of plastic (through the extrusion machine) gives him the euphoria of a prestigious free-wheeling through nature.' [4, Barthes]

A proliferation of consumer goods created an inflationary culture that invested ever more of its psychological well being into acquiring material things. But, paradoxically, it was invested into objects of such low value as to encourage their displacement, their disposal, and their quick and total consumption, in order to go out and buy more. It was a perfect ever-hungry market. Plastic became the material of choice. The material's virtues were limitless. It was inexpensive because it was derived from a seemingly endless supply of petroleum. It was less solid or intractable than wood or steel. It was free of traditional preconceptions regarding its use and could be moulded into any shape a restless drive for novelty might conceive. It was so lightweight and in some forms so insubstantial as to be discarded without a second thought. The new culture gloried in its own transience.

Plastics reached their apogee in futuristic products such as waterbeds and inflatable domes and images such as PVC clad go-go dancers. The 'Plastic as Plastic' exhibition in New York in 1968 gloried in the possibilities of plastics, epitomised in a room of sprayed polyurethane foam, described as the first 'completely abstract, totally synthetic environment' in the history of construction.

First concerns: aesthetic and cultural

A decade after Barthes' essay was written, however, perception of plastics began to change from curiosity and wonder to contempt and

revulsion, especially in the US. The word plastic had become an adjective meaning fake or insincere. Plastic became both an epithet and a metaphor for a spiritually hollow society that worshipped material consumption. The backlash against plastics began in the late 1960s and early 70s in the US and to a lesser extent in Europe, just as the baby-boomers came of age. The first concerns were cultural and aesthetic.

In 1970, shortly after the first Earth Day, US furniture designer Paul Mayen complained about the havoc wreaked on the environment by 'an inflationary mentality'. As he saw it, the economic success of technical processes capable of fabricating plastic furniture in increasing numbers depended on popular acceptance of the idea of 'expendable furniture'. But in a supreme irony, while a fast-paced lifestyle led people 'to cry out for more and more of these throw-away objects, such things had become more durable than us, our governments, and our society'. Mayen argued that society had to stop making things 'with such a high pollution potential' and instead develop plastics with 'high reconversion potential'. [38, Mayen]

Expansion of plastics mirrored a civilisation in pursuit of material goods. To some young people, especially those of the middle classes who enjoyed the benefits of the post-war economy, American values seemed superficial, 'as phoney as wood-grain laminate or PVC leatherette'. The material did not ring true, nor did the society that produced it. Plastic was the material embodiment of everything phoney in American life, its emotional shams and makeshift gratifications, its false fronts and Tudor suburbs, its willingness to let 'cash value' determine values. 'Plastic, man!' was an epithet of the hippie revolt.

The editor of Modern Plastics, Sidney Gross, complained that plastic's reputation 'remained as low as it can get despite a phenomenal growth rate'. 'Somebody must like the stuff', was his grumpy conclusion. 'If they hate plastic so much how come they are buying more and more of it?' [39, Gross] Indeed, by 1979 plastic consumption had surpassed that of steel in the US. But by now the consumer had little choice. A poor image had little effect because consumers could only choose from goods presented in the market place. If manufacturers chose plastic – whether for versatility lower cost, greater profit or whatever reason – then consumers had no choice but to buy plastic

or not buy at all. Manufacturers chose plastic not because it used lighter, 'cheaper', raw materials or because it made 'better' products, but because one-shot automatic moulding operations eliminated the cost of separate fabricating, finishing and assembling operations. This reduced labour costs and made plastic products cheaper than either traditional or bio-based raw materials.

Health problems with plastics

In the 1970s and '80s evidence started gathering about specific health problems caused by plastics. It started with plastic bags suffocating babies, and fumes from accidental fires, then progressed to workers' contracting death-causing diseases in the PVC industry. By the 1990s, with growing improvements in analytic science and more evidence accumulating of the potential effects on the environment and human health, environmental regulators started to limit exposure to the many harmful chemicals used in plastic processes.

Environmental attention no longer focused on plastics generically but on specific problems of particular plastics and especially PVC, slowly becoming dubbed 'the poison plastic'.

In the 1980's the global influence on climate of burning fossil fuel started to be calculated. At the same time awareness grew that we were fast using up all the earth's finite resources, and, as a consequence, accelerating environmental degradation.

Disney World: the apotheosis of plastic

By far the most influential developments in plastics, both in technology and marketing, originates from the north, and in particular the US. This is inextricably linked to the north's dominant control of the global oil supply – the base material of thermoplastics.

Perhaps the apotheosis of this culture is Disney World, whose fundamental message is that technology can give us more reality than nature can. Disney World's purified and sanitised simulation, where Mississippi riverboats, fairy tale castles, rocket ships and Main St, US, can equally fill the reality of a single moment.

Hardly surprising, much of Disney World is made of plastic: fibreglass reinforced polyester faces the exterior and interiors of most structures; the soaring blue spires vaguely suggesting slate have been

fabricated from sheets of PVC and acrylic and designed to withstand 120 mile-an-hour winds. Simulation entered a new realm at Epcot Center which offered the attractions of a corporate-driven, high-tech utopian future and the pleasures of a risk-free photogenic visit to romantic countries around the world. Take Italy – made of reinforced polyester – where across a tiny Piazza San Marco from the Doge's palace stands a two-story stucco country house (polyester). Its water stained walls (painted with plastic paints) show trowel marks, and ancient cracks and scattered pockmarks. In such details Disney's engineers exhibited extraordinary confidence. They were so certain of control over past, present and future so convinced of reality's plasticity that they dared simulate the very process of decay.

In April 1998 Disney opened a 'real' animal kingdom in Florida, US. At the centre is a 14 storey, 145-foot high 'Tree of Life', an imitation Banyan tree. In an interview on his own media company, ABC Television, the chairman of Disney, Michael Eisner, said, 'The last time somebody created a river and a park and a world like this, it was you know, found in the Book of Genesis.' [40, Observer] The chairman of Disney sees himself as the natural heir of the Christian God.

3 Petrochemical strategic planning in India

'India has already entered the Plastics Age, and certainly one will now witness revolutionary, rapid and unstoppable growth.'

Nirmal Thakkar, Economic Times, 19th October, 1993.

The plastics industry, like other forms of northern industrialisation, came slowly to India. Under British colonial rule there was little pressure to build a strong industrial base in India – the small consumer market that existed was served by imports of goods from Britain. Even in the period leading to Independence (1947) and beyond, there were pressures to resist industrialisation. 'In a country where the great weight of numbers and considerable wealth lay in the country-side, there were relatively few pressures to industrialise, still less to redistribute or to effect social changes.' [41, Khilnani]

Gandhi led a movement that openly rejected mass-production, urbanisation and westernisation. He extolled the values of simple village life, an ethic of austerity and self sufficiency (swadeshi) based on subsistence agriculture and small-scale cottage industries. India was a different society then, a society of little spatial mobility; in 1931 less than 4% of the Indian population moved outside the state or province of their birth. [41, Khilnani]

The development of the plastics industry in India

The Indian plastics industry began in the 1920s using imported cellulose sheets and rolls for making consumer products such as bags, combs and other decorative items, exclusively for the home market. In the 1930s industry widened its base with imported compression moulding machines. The initial processing was confined to thermoset resins. The first moulding powder and resin to be produced in the country was phenol formaldehyde moulding powder in 1948. From the mid-1940s industry made rapid strides of progress in machinery and processes and started catering to high-tech products used in engineering, construction and textiles.

Unlike in the US, provision of consumer goods was never a priority of India's democratic founding fathers. Nehru believed that an independent India could follow three ends simultaneously: industrialisation directed by the state, constitutional democracy, and economic and social redistribution. [41, Khilnani] The state would have a paternal role, providing infrastructure, investing in expensive industries like steel and protecting Indian industry from predatory foreign capital. Development in the 1950s and 60s was symbolised by the building of huge concrete dams, the 'new temples of India'. Petrochemical expansion, however, remained small and of secondary importance. Not surprising as India was (and continues to be) an oil-poor country, and would have had to depend on foreign imports and therefore suffer an outflow of capital.

Although the entry of foreign capital was discouraged, in the absence of indigenous technology and expertise the first ventures into integrated petrochemical production were either fully or partly foreign-owned. The earliest Indian petrochemical plants were built and substantially owned by Multi-National Companies (MNCs). In 1966 US Union Carbide set up a wholly owned ethylene plant with an annual capacity of 10,000 tonnes in Bombay. Two years later a Joint Venture (JV) between NOCIL and Shell started a petrochemical complex with capacity of 60,000 tonnes.

Thermoplastic production began in the 1950s with a non-petroleum feedstock base. The first polystyrene and low-density polyethylene (LDPE) plants of small capacity (in the order of 5,000 tonnes per annum) used ethyl alcohol from molasses and benzene via coke oven production. With the availability of ethylene, production facilities for high-density polyethylene (HDPE) and PVC were

established. The commissioning of three scale polymer plants for LDPE, PP and BR (Butyl Rubber) helped Indian industry to significantly increase overall production of plastics.

This tempo of growth, however, slowed with successive crises faced by the industry in the 1970s. The major global oil crisis in 1973 forced massive increases in feedstock prices for the petrochemical industry in India. This caused an occasional slow-down and often stagnation in the growth of consumption – aided by a restrictive import policy. [42, Shah]

In the late 1980s, as part of the 7th plan (1986-90), the Indian Government sanctioned a number of petrochemical complexes with proposed investment of Rs30,000 crore (approximately US$75 billion). One of the main reasons for this huge promotion of the petrochemical industry was that India was becoming increasingly dependent on imports of commodity plastics and sought to become self-sufficient.

> 'Although there has been steady growth in the consumption of petrochemicals, the growth potential has not been fully realised due to high degree of import dependence, which is procedurally cumbersome and the end-use industry, being predominantly small scale in nature, cannot realise its true potential based on imported raw materials. In fact the import dependence for commodity plastics increased from 30% in 1979-80 to 59% by 1990-1. In view of this the government sanctioned several petrochemical complexes during the 7th plan period (1986-90).' [9, GOI Mohan]

The Indian Government thus encouraged 'the setting up of a petrochemical industrial base within the country (that) will not only usher in raw materials security but also give an impetus to research and development efforts, make room for growth and development of capital goods industry, besides providing jobs to large numbers of scientific/ technically trained personnel'. [43, GOI Bhattacharya]

This impetus was halted in the early 1990s as India underwent a serious balance of payments crisis. The situation was aggravated by the Gulf War, which saw almost a doubling of international prices of polymers. India, being a major importer of oil feedstock, found it difficult to service its domestic market and around 20,000 plastic

processors in the country had to cut down production levels to around 50% of their capacity. The crisis led to the imposition of up to 200% margin on imported goods and led to the virtual closure of a number of downstream industries. In 1991 the government announced a comprehensive package involving exchange rate adjustments, fiscal correction and structural reforms in trade and industrial policy, in an attempt to balance out the problem.

The effect of the 7th plan 1980s investment is being experienced today. The leap forward was led by Reliance Industries, India's largest private sector enterprise. In 1997 they finished completion of their 'ambitious world-scale plant' at Hazira, near Surat in Gujarat. At the end of 1999 they commissioned what is possibly Asia's biggest refinery at Jamnagar in Gujarat. Now the most efficient vertically and horizontally integrated petrochemical company in India, they dominate the market for PVC, HDPE, LDPE and PP. The other main players in the commodity plastics market in India are part government owned IPCL, Chemplast Sanmar, NOCIL and Finolex.

The long-term aim of government planners is to enable the petrochemical industry in India to 'acquire a competitive advantage against foreign competition within the country and in the long term, the objective would be to acquire a competitive advantage in the global market'.

> 'The petrochemical plants set up in the 70s and 80s were of tiny size compared to world standards as the domestic demand did not justify the world scale plants. But, the current economic policy adopted by the Government of India calls for Globalisation and petrochemicals are no exception. Hence there is a need for setting up of economically viable complexes which can produce petrochemicals at internationally competitive prices.' [9, GOI Mohan]

The decision making process

Until recently intellectuals and technocrats from the urban elite have closely controlled economic policy. During the Nehru era, from Independence to the mid-1960s, economic development was entrusted to a small group of around 20 men, called The Planning Commission. It became the exclusive theatre where economic policy was formulated.

Key economic strategy was removed from parliament and the cabinet – they were merely informed of decisions taken by the small cohort of experts. The members of The Planning Commission were not all economists. Nehru chose them for their broad agreement to his political agenda: committed to 'socialistic' and reformist ideals, in the Indianised version of social democracy. Above all they shared his scepticism about the market and a belief that the state had to take responsibility for allocating resources in the economy. [41, Khilnani] The results of their deliberations were issued as a series of Soviet-style 5-year plans.

From the mid-1960s onwards, as this centralised planning process was seen to have led India into a succession of economic crises, the influence of The Planning Commission waned. Both Indira and Rajiv Gandhi, in the late 1970s and 80s pursued policies to radically 'modernise' the Indian economy. The needs and influence of industry started to dominate. Although economic policy is still centrally directed by a succession of five year plans, it is more influenced by politicians and private capital.

The procedure is now as follows. The Planning Commission provides a draft five-year plan – a proposed direction for the Government of India to take. The Chief Ministers and Finance Ministers from all States debate it in the Lok Sabha, the Indian parliament. Once the National Development Council has given approval to the plan, or part thereof, each year the plan is incorporated into the budget.

The expansion of the petrochemical industry has therefore been sanctioned through a complex process of proposal and acceptance. For brevity three key government reports shall be referred to as those of the chairmen, the Hasmukh Shah, Chinmay Bhattacharya and Rakesh Mohan reports.

1986 Hasmukh Shah Report 7th plan (1986-90)

The first key official report on the petrochemical chemical industry in India, published in 1986 was 'The Report of the Committee for Perspective Planning for the Petrochemical Industry'. This was a report of The Government of India, Ministry of Industry and Department of Chemicals and Petrochemicals. Significantly, the Convenor of the Committee, Hasmukh Shah, was the chairman of IPCL, which at that

stage was a company fully owned by GOI. The voice of industry completely dominated the Committee. Even the secretariat of the Committee was provided by IPCL. Other industries whose support was acknowledged by the Committee are as follows: EIL (Engineers India Limited), NOCIL and PIL (Polychem India Ltd). The Committee approached 37 people for their views – almost two thirds were from industry, the balance being academics.

A series of assumptions are made in the forward to the report, promoting the petrochemical industry as a thrust area for development, and describing its products as superior to the traditional products they were designed to replace.

> 'The petrochemical industry in India is on the threshold of substantial expansion and growth during the Seventh Five Year Plan period (1986-1990). It has been identified as a thrust area and a major source for a wide range of economically efficient and quite often functionally superior synthetic products compared to conventional materials like paper, wood, leather, cotton, aluminium, steel and tin'.

1993 Bhattacharya Committee 9th and 10th plan (1997-2006)

The 9th and 10th five-year planning report also had a large number of industry representatives among its co-opted members, in particular in the Working Group employed to prepare a perspective plan. Significantly, IPCL and Reliance seconded its marketing professionals as members of the sub-group. In all 35 officials from industry were co-opted and 3 from government.

The Bhattacharya report promotes petroleum products to meet not only the basic needs of the Indian people, but also the 'entertainment' needs. The report explicitly defines what the Indian people 'need'.

> 'The petrochemical products assist in providing wherewithal for meeting basic human needs – food, clothing and shelter. These also play an important role in medicare, education and entertainment and a variety of household requirements. Petrochemicals find application in a whole host of value added chains which help in improving the quality of life. In the times to come, pressures on land water and environment are bound to increase

phenomenally. It is in this context that the need for exploiting the full potential of petrochemicals becomes critical.'

1993 Rakesh Mohan Committee

The GOI Rakesh Mohan Committee's 'Experts' Group Report on Petrochemicals' was published in 1993, the same year as the Bhattacharya report. This continued to emphasise the importance of the Indian petrochemical industry, in particular its role in materials' substitution, its contribution to the national economy by way of employment, excise and customs revenue and as an earner of foreign exchange through exports.

Above all the Rakesh Mohan report emphasises the importance of the petrochemical industry to the economy of India.

> 'Thus petrochemicals in the form of various products contribute to economic growth by way of being high growth industry coupled with high technology and skilled manpower inputs.'

Questioning Assumptions

One of the purposes of this book is to examine the assumptions behind Indian government promotion of petrochemicals, as expressed by the reports of these committees. Six main assumptions stand out as being the rationale behind the large percentage increase in planned supply of plastics in India. They are outlined in Government of India documents and repeated by government, industry and its allies in promotional literature and at conferences. Summarised thus:

- The plastics industry in the form of various products contributes to Indian economic growth by way of being a high growth industry. It is hoped that the export of plastic products will substantially contribute to India's foreign exchange earnings.

- Expansion of the plastics industry will increase employment and skilled manpower.

- Plastic products are essential necessities and assist in providing the wherewithal for meeting basic human

needs – food, clothing and shelter, as well as improving quality of life.

➡ With the depletion of scarce natural resources plastics are the inevitable source of many material needs.

➡ Plastics are environmentally friendly. A key part being their lower energy content.

➡ India can effectively deal with plastic wastes through the informal recycling sector.

Plastics for the poor

One of the key purposes of economic policy in India, from Nehru to today is 'to lift the age-old burden of poverty', to quote the architect of the post 1991 'liberalisation' programme, Finance Minister, Manmohan Singh in his 1995 budget speech. Lifting 'the burden of poverty' has traditionally entailed providing the five basics – roti, kapda, makan, swastha, shikhsa – food, clothing, shelter, health and education. [27, Bakshi] These basics are the survival for the 300 or so million Indians who are far removed from consumer society and the bulk of products offered by the plastics industry.

The Government of India hopes to achieve the eradication of poverty by a 'two track strategy of accelerating growth, investment and modernisation on the one track, and strengthening anti-poverty programmes on the other'. [44, GOI] Particularly through economies of scale, volumes and mass production, the petrochemical industry is promoted as a 'growth industry'. Through the 'trickle-down' effect, because of increased economic activity, it will benefit the poor. With mass produced and affordable petrochemical plastic products – PVC shoes, plastic sheeting for slums – it will help to clothe, shelter, and grow food for the poor.

> 'The liberalisers argued that India must create conditions for growth, since indisputably this was necessary for any alleviation of poverty...An excited sense that India had now reached the point of 'take-off' gripped policy makers, politicians and industrialists (in the early 1990s). One economic advisor to the government concluded his argument for liberalisation with a fly-past of extreme confidence: if the appropriate policy was followed, 'the

> growth rate of the economy can be accelerated and sustained at an average level of 7-8% per annum. If the economy continues to grow at this rate, per capita income can be quadrupled by the year 2020.' [41, Khilnani]

This conventional capitalist economic wisdom, of which the Government of India petrochemical planning process is an example, is rooted in the north. Redefining poverty and development in purely economic terms was a key feature of the northern post war era. In 1948 the World Bank, in one of its first reports, related poverty unequivocally to Gross National Product (GNP). The report postulated that those countries with an average per capita income of less than US$100 were by definition poor and underdeveloped. 'For the first time in history entire nations and countries came to be considered (and considered themselves) as poor, on the grounds that their overall income is insignificant in comparison with those now dominating the world economy.' [45, Rahnema]

> 'Poverty became a measure of a person's lack in terms of 'needed' goods, and even more in 'needed' services. Poverty became an abstract universal measure of under-consumption. Those who survive in spite of indexed under-consumption were thereby placed into a new, sub-human category, and perceived as victims of a double bind. Their *de-facto* subsistence became almost inexplicable in economic terminology. While their actual subsistence activities came to be labelled as sub-human, if they were not frankly viewed as inhuman and indecent.' [3, Illich]

The New World order was expressed through the famous Point Four Declaration of President Harry Truman in his Inaugural Address in 1949. He advocated industrial progress in order to 'raise the standard of living' for the 'undeveloped areas' of the world. His aim was to 'lighten the burden of the poor'. He saw 'greater production as the key to prosperity and peace'. As Estava wryly commented, 'underdevelopment began then on January 20th, 1949'. [46, Estava]

The advent of the world economy, with all its realities and accompanying myths (the existence of unlimited resources, technological miracles, endless consumer goods, induced needs etc), created a new set

of universal reference points. The most influential of which led entire nations and continents to believe that they were poor and in need of assistance, only because their per capita income was below a universally established minimum.

Not only did 'poverty' get re-defined, for some created, but the economic system that evolved has failed miserably to eradicate it. 'There is no evidence that affluence has, anywhere, improved the poor's condition.' [45, Rahnema] Khilnani uses the example of Brazil, a similar economic situation to India. Brazil has also seen impressive growth rates, and its development was once called miraculous, but many out of its 150 million inhabitants 'live in extreme poverty earning less than US$65 a month. In India's case, scarred by poverty, illiteracy, poor health and sharp gender inequalities, the likelihood of tramping the 'Brazilian path' is high. Growth produced by 'un-aimed liberalisation' which was not specifically targeted at improving the conditions of the worse-off, could surely be expected to increase inequalities in three ways: across the country it would widen the gap in social opportunities available to rich and poor; it would sharpen the divide between rural and urban India (urban incomes are around three times the size of rural ones, while female literacy rates in cities are more than double those in the countryside); and it would increase the already pronounced imbalances and differences among the regions, which gave the richest of them per capita incomes three times higher than the poorest ones'. [41, Khilnani]

While the poorest 20% received 2.3% of the world income in 1970, twenty-one years later this share fell down to 1.4%. [20, Diwan] The United States, the richest country in the world, has yet to recognise that 30 million of its citizens live, by their definition, below the poverty line. [45, Rahnema]

At the same time this same economic system has benefited the 'rich', in equal amounts as it has made poorer the poor. As finance capital has grown, so have the income inequalities. According to UNDP's Human Development Report 1998, the income disparity between the richest and poorest 20% of the world's population is now 150 to 1, having doubled between 1960 and 1990. [47, Clarke] As the UK Guardian newspaper put it in response to a question about the difference between Zambia and Goldman Sachs: 'One is an African country that makes 2.2 billion a year and shares it among

25 million people. The other is an investment bank that makes 2.6 billion and shares it among 161 people.'

Not only has the system failed the poor economically, but 'the very economic activities deployed in the name of the poor impute to them different needs of a more insatiable nature', icons of material success (made or cased in plastic) are held up for them to attain. They must be part of the consumer society or they fail. These further expose the poor to situations of even more complete helplessness. In short, Rahnema concludes, what the poor need is not the production of economic resources or services, which ultimately benefit others or the generations to come. 'It is rather the recovery of their actual capacity to tap their own vernacular, locally available resources – which are totally different from what economists call resources.' [45, Rahnema]

So let's get this assumption right out of the way at the beginning. The promotion of plastics is not to help the poor, but ironically it is the very poor who are left to clear up the waste.

Part 2
Government of India assumptions

4 The economics of plastics

'The current economic policy adopted by the Government of India calls for Globalisation and petrochemicals are no exception. Hence there is a need for setting up of economically viable complexes which can produce petrochemicals at internationally competitive prices.'

Government of India, Rakesh Mohan Experts Group Report on Petrochemicals, 1993

The promotion of plastics in India is driven by those who wish to make money – the most important assumptions in all the Government of India petrochemical reports are to do with markets and numbers. The demand of petrochemical products can be vastly increased because India is a scarcely tapped market for such products and the number of potential consumers is enormous. Every industry spokesperson and commentator, repeats the statement that India has one of the lowest global per capita consumption of plastics: 2.1 kg as opposed to a world average of about 13kg and between 40-60kg in the industrialised countries of the north. Therefore, it is anticipated that India, with a current population of around 1 billion people, will soon increase its consumption of plastics at least to 4kg per capita. One third of this population is destitute (in conventional economic terms) and does not, and probably will not, have disposable income to consume much in the way of plastics or other goods. However, one third of the population is the up and coming middle class, whose aspirations can be moulded (like plastic)

into buying products such as cars, washing machines, televisions, sound systems and the like, in which plastic is a key ingredient

India's potentially huge domestic market for petrochemical products has not surprisingly attracted foreign capital and technology in the same way that China has become a lure for investors.

> 'China's current economic growth relies on what can be thought of as an 'ultimate combination' of factor endowments: an infinite low-cost labour base; high productivity growth without a corresponding impact on wages; a huge attractive domestic market; the negotiating power to attract world best practice in any industry; the coexistence of several regions following different economic development models; solid credibility on international financial markets; an acceptable level of political instability; and a very high level of political independence. In the rest of the world only India comes close to sharing such a happy combination of characteristics.' [48, Business Week]

India has further advantages over China: 'Foreign financiers point out that India has many assets that China lacks – a base of veteran entrepreneurs, an English speaking elite, well established capital markets and a rule of law.' [48, Business Week]

Globalisation of Indian petrochemicals

The more recent utterances of Indian government planners have been less about alleviating poverty and more about the importance of the 'market'. To help the petrochemical industry in India, 'acquire a competitive advantage against foreign competition within the country and in the long term, the objective would be to acquire a competitive advantage in the global market'. [9, GOI Mohan]

Until 1991 India's domestic industry enjoyed protection from international competition by way of tariffs and import controls. But this had the counterbalancing effect of making Indian manufacturers uncompetitive in the international market, both in selling their products and in buying raw material. Therefore, Mohan recommended a revision of tariff controls: 'Now it is necessary to identify and initiate policy which can help this industry acquire a global competitive edge.' [9, GOI Mohan] The process of liberalisation is best characterised by the progressive lowering of customs and excise duties on key feedstock and bulk products. After the liberalisation of 1991, customs duties on

petrochemical products were lowered sharply from 130% to 30%. (See Table 6) [49, Ramanathan]

Table 6 Customs duties 1992 and 1998

Duty	1992	1998
Customs Duties Polymers	50%	30%
Customs Duties Other petrochemical products e.g. PP	120%	10%
Excise Duties Polymers	31.5%	25%

Source: [50, INFAC]

Already by 1993, there was great hope from these reforms. As the Bhattacharya report states:

> 'The economic reforms have brought about removal of capacity licensing by the GOI, significant reduction in import barriers, both tariff and non-tariff, easy access to imports of capital goods, technology and raw materials.... The benefits of reforms have percolated to the industry, and the economic activity in the country in general, be it scales of operation, technology, cost effectiveness, funding instruments or international trade.' [43, GOI Bhattacharya]

Given the active promotion of the petrochemical industry by the Government of India from the mid-1980s onwards and the projected demands of this huge potential market, one would have expected by now to see a flourishing industry where supply matched demand, where the industry was not import dependent, and exports onto the global market have substantially increased. For the most part this has not happened.

Growth targets not met

The reports of the Government planners were formulated at a time when the petrochemical industry in India was recording impressive growth – in the bullish markets of the early 1990s. 'Whereas demand is stagnant or merely matching GNP in Europe and the US, the petrochemical industry in India is recording impressive growth. During the 7th five-year Plan (1986-90) GNP grew at 5.5% annually. While growth rates for the industrial sector were 8.8%, those for the chemical and petrochemical industries grew 10% and 12-15%'. [51,

Indian Express] In this bullish climate the investment in plastic processing was expected to rise from US$1.5 billion to US$4 billion by 2001. [52, Reliance Industries Ltd]

However, in the second half of the 1990s there was a definite slowing down in growth in the Indian petrochemical industry. According to Mr Mani, Secretary of All India Plastic Manufacturers Association in March 1998, 'For the past 18 months there has been no investment in the processing sector. Because of political uncertainty, policy changes in the areas of finance and investment, stagnation of demand, the plastics industry is in the doldrums.' [53, Ram] In a financial round-up of the nation's chief industrial sectors in 1997, Business India said of petrochemicals: 'The sector, after recording a heady sales growth of over 30% for two straight years from 1994 to 1996, slumped to 7% during 1996-7 following a downturn in international prices.' A closer look at these figures reveals that these results have been skewed by Reliance Industries' high performance. 'If Reliance is excluded then sales growth dips from 30% to less than 1% and the net profit showed a negative growth of 33%. This represents the true state of affairs in the petrochemical sector.' [54, Business India]

With the possible exception of India's premier petrochemical company, Reliance Industries, growth has slowed down and in certain sectors there is negative growth, supply and demand figures are unbalanced, tariff walls have been raised, exports are falling and India still remains import dependent on plastic products.

Supply and demand unbalanced

With their earlier bullish optimism, Government planners for industry predicted that supply would not exceed demand through to the end of the 10th five-year planning in 2007. 'All commodity plastics are going to be in short supply in 2001/2. There is considerable scope for increasing capacity production particularly in polyethylene's and polypropylene.' [43, GOI Bhattacharya] However, while public documents projected that demand would absorb capacity, an internal industry supply/demand forecast that we obtained showed that, by the year 2000, demand rate would be almost stagnant and production greatly exceed demand, in one key commodity plastic, PVC (see Table 7).

Table 7 Indian supply/demand assumptions in PVC (tonnes)

Supplier	1994	1995	1996	1997e	1998e	1999e
Chemplast Sanmar	38,488	42,159	43,351	49,000	55,000	55,000
DCW Ltd	41,909	45,194	55,000	54,000	54,000	54,000
Finolex Industries	14,326	85,840	122,000	130,000	130,000	130,000
IPCL Baroda	50,386	52,465	54,000	54,000	54,000	54,000
IPCL Gandhar	nil	nil	nil	11,000	105,000	142,000
NOCIL	26,000	27,000	25,000	25,000	25,000	25,000
Reliance Industries	170,304	186,597	186,511	192,000	272,022	293,022
Shriram	35,084	34,448	39,000	30,000	30,000	30,000
Total Supply	376,497	473,703	524,862	545,000	725,022	783,522
Supply Growth rate		26%	11%	4%	27%	8%
Demand	355,000	396,000	440,000	484,000	537,240	596,336
Demand Growth rate		12%	11%	10%	11%	11%
Surplus (deficit)	21,497	77,703	84,862	61,000	187,782	187,186

Source: Confidential data JV investment bank July 1997

The over capacity in the domestic market indicated either a lack of demand or that demand was being met by lower priced imports.

> 'Observers in the petrochemical industry say the companies have had massive cuts in the past two months following glut (of PVC) in the market. Ex-factory prices in the last two months have dipped to Rs27 per kg. As against the demand for 4.8 lakh tonnes (480,000), the market is flushed with 5.43 lakh tonnes of PVC. With low volumes and wafer thin margins, the low prices, poor market reach and no discounts have resulted in a fall in market share of Finolex PVC to 9-10% and Chemplast to 5-8%.' [55, Financial Express]

The knock-on effect of the supply/demand figures on per capita consumption in India has been made worse by the pricing policy and encouraged dumping, making domestic demand projections even worse.

Restoration of tariff barriers

To protect its home market from cheap imports, India had to raise its tariff walls yet again. At the behest of industry, the June 1998 Union budget put a special duty of 4% on petrochemical products.

When it had previously lowered tariff barriers both for imports and exports, smaller companies like Chemplast Sanmar and NOCIL felt pressured from imports. 'In the wake of liberalisation and slashing down of import duties from 300% to 25% on products, Chemplast Sanmar is unable to compete with international competitors. In PVC, Chemplast plant at Mettur is not as competitive as the two majors – Reliance and IPCL. It could tide over the problem only if it is able to create a capacity of 1.5 lakh tonnes (150,000) at a cost of Rs1, 000 crore (US$250 million) near a coastal belt.' [56, Economic Times] Foreboding expressed in the Rakesh Mohan report may be materialising: 'the policy of gradually lowering the tariff levels can also put the domestic industry on the docks, if it is not an economic producer capable of withstanding international competition'. [9, GOI Mohan]

Exports are down

Despite the predictions of government planning reports that petrochemical products would be a significant export industry and a key source of foreign income for India; this has yet to happen. Growth of exports in the first half of the 1990s did expand, but the situation now appears to have been reversed.

> 'During the first half of this decade, the export of articles of plastics alone registered a growth of 42%, increasing from US$74 million to US$300 million in 1994-5. [43, GOI Bhattacharya]
>
> 'Exports of plastics-related products during fiscal year 1997-8 have been sharply lower than the targeted US$720 million as per the latest figures available. For the 10 month period up to January 1998, total plastics related exports are placed at US$433.60 million, 8.5% up from previous years US$399.30 million.' [55, Financial Express]

According to the Plastics Export Promotion Council (Plexconcil), 'Exports of plastic goods during the year to March 1998 have been placed provisionally at US$608.16 million, up just 5.16% over the previous years US$578.32 million. Against the set export target of US$720 million, the exports during the year were lower by US$111.84 million, or 15.53%'. [55, Financial Express] No industrially

manufactured product, with the possible exception of textiles, has emerged as a significant new source of foreign exchange to India. *'Instead the creative abilities of its peoples have become the potential springboard for India's great leap forward, the service exports in software, consultancy, health services and legal expertise.'* [57, India Today Editorial]

India remains import dependent on key commodity plastics – PP, HDPE and LLDPE, as Table 8 shows.

Table 8 Import dependency of key petrochemicals in India
(figures in 000 tonnes)

Product	Imports	Consumption	%Import
Propylene (1998)	602	50	8.30
PVC (1997)	55	558	9.85
PP (1997)	220	430	51.16
HDPE (1997)	200	483	41.00
LLDPE (1997)	55	138	40.00

Source: Investment Research and Information Services

Global cycles and the South East Asia crisis

The depressed state of the Indian petrochemical industry and the recent rise in tariff barriers is partly due to the cyclical nature of the global petrochemical industry. In an article in the Economic Times, the Chairman and Managing Director of IPCL, K.G. Ramanathan expressed it thus: 'The petrochemical industry internationally is known for its recurring business cycles. Of late, South East Asia, which has emerged as a dominant player in the petrochemical field, has been plagued by supply/demand mismatches, resulting in depressed markets.' [49, Ramanathan]

The situation has been exacerbated financial turmoil in South East Asia in the late 1990s. Devaluation of South East Asia currencies resulted in cheap imports threatening Indian markets. Prices of all Indian petrochemical products crashed, and, as a result, Indian industry faced tremendous pressure on margins. According to a Business Standard analyst, 'The bottom has not yet been reached. This is because while companies in South East Asia have cut production, few have actually closed shop. Even before the crisis, several Southeast nations particularly Korea, were in surplus. In order to counter the over 20% slump in demand, export allocations of all the Southeast nations, particularly Thailand, Korea and Taiwan have zoomed'. [58, Business Standard]

The analyst ended by advising 'Any investments in this sector are best held in abeyance as no company is expected to outperform the market'.

In effect South East Asia dumped products on the open market. Dumping is the almost inevitable outcome of the opening up of markets by lowering the protection of tariff walls. It usually involves a strategic dumping of products on the open market at low prices, often below cost price, in order to generate cash flow. While lowering tariff and customs walls made Indian industry more competitive (principally by lowering its costs of raw materials, oil in particular), they also made the industry vulnerable to foreign competition. Rakesh Mohan predicted this in 1993: 'The need for anti-dumping measures can hardly be overestimated in view of the current world scenario in petrochemicals where over capacities could become endemic. In a situation of over capacity exports are a means of survival and this holds true for many of the developed and developing petrochemical producing countries. Under the circumstances, these countries would target their exports to those countries, which are in the process of liberalising their imports through a lowering of tariff and non-tariff barriers. India could be one such target in the future.'

The Rakesh Mohan report recognised global economic uncertainties and the dangers of a huge increase in capacity. 'The risk of over capacity from a wave of investment hangs over the world petrochemical scenario. The price, margin and operating rates of major olefins, aromatics and derivatives dropped significantly in the 1990s. (Yet) installed capacities of ethylene is expected to grow from 64 million tpa (tonnes per annum) in 1991 to 82.4 million tpa in 1996 against a demand increase in the corresponding period merely from 50.5 million tpa to 61 million tpa. Recent forecasts indicate that the cycle might bottom out around 1995-6 for a return to good times – though not nearly as good as 1988/89.' [9, GOI Mohan] While Mohan was correct in recognising the dangers of over capacity, his forecast of a return to better times has not yet materialised. Clearly, when sanctioning increased capacity and recommending the lowering of tariff walls, government planners overestimated the ability of the Indian petrochemical industry to become globally competitive.

Weaknesses of the Indian petrochemical industry

It's not just the vagaries of the global cyclical problems that the Indian petrochemical industry has to grapple with. Indian industry and other 'development projects' suffer from a number of inherent problems that could take decades to overcome, if at all. These can be roughly divided into higher production costs and infrastructure problems.

Domestic Resource Cost

To examine the overall competitive strengths and weakness of the petrochemical industry, Rakesh Mohan used the Domestic Resource Cost (DRC) concept. The purpose of a DRC evaluation is to ascertain the cost of the industry to the economy, based upon its economic rate of return.

The petrochemical industry in India gets a mixed DRC evaluation. One author, Dr. V. Kalkar for the Asian Development Bank concluded that 'Overall, the chemical and chemical based industries do not demonstrate favourable DRC which would justify the allocation of large investment resources to them. The country is structurally deficient in the basic feed-stocks for petrochemical industries and together with a relatively low scale of production, the cost of production is raised well above international levels'. [9, GOI Mohan] Table 9 describes the actual cost of producing commodity plastics across countries in the south. Taking the mean total, the costs to India and China, are the largest followed by Indonesia.

A subsequent study, carried out by Professor Sen Gupta for the Planning Committee, concluded that, 'The polyester fibre and acrylic

Table 9 Commodity Plastics – economics of manufacture cross country comparison
(Price in US$ per metric tonne)

Product	India	Korea	China	Thailand	Malaysia	Indonesia
LDPE	785	726	794	710	664	764
HDPE	696	676	733	649	584	665
PP	700	665	671	665	654	700
PS	912	863	895	865	-	903
Total	3093	2930	3093	2889		3032

Source: [9, GOI Mohan]

fibre as manufactures in India are not internationally competitive while other thermoplastics items have favourable DRCs'. However, the Sen Gupta study was based on the assumptions of 600,000 tonnes monster cracking capacity, with no taxes or duties on any inputs of feedstock supplied at international prices.

Capital and operating costs

The major costs for the Indian petrochemical industry were outlined in the Rakesh Mohan report, 1993, as follows:

For capital costs:

- High capital costs. Mohan judged that the 'capital cost of similar plants in India today are 1.4 to 1.6 times that of international levels'.
- High import duties. 'While import duty levels have been brought down substantially, it is still very high when compared to developing countries in our neighbourhood.'
- Long gestation period. Excessive bureaucracy and planning procedures mean that the gestation time for new projects has been 'three to four times longer than that in developed countries'. 'Delays are due to layers of bureaucracy, indecision, political, regional and economic considerations, divergence of views among ministries and lack of an overall feedstock policy/ framework.' Mohan is particularly exasperated by the excessive complications of the licensing procedure.
- Infrastructure shortages. Notably power, water, transportation and other support facilities are inadequate. 'Availability of adequate water at an affordable price for the normally heavily water dependent petrochemical units is still not certain.'
- The high transportation costs are in part due to the particularly hazardous nature of the commodities involved, via a network 'which is not at its best in India'. Mohan interestingly links this with 'consideration of safety and environmental protection', although no details are given, and no other environmental costs are detailed, for example, clean up technology.

For operating costs:

Due to overall inefficiency 'our costs of production are almost two times that of international costs'.

- High duty structure on imported feedstock and uncertain quality of feedstock.
- High cost of utilities such as power, water and fuel. Caused by huge losses in processing through frequent power failure, often leading to total breakdown which can take as long as 15 days to restore. 'This is not withstanding the loss of output, wastage of raw material and fuel besides the cost of new equipment to replace damaged items'.
- High maintenance costs because of the high imported component of machinery. This requires maintaining high inventories of spares. In the absence of a reliable power source from the state, new plants have the additional capital and operating costs of providing their own captive power facilities.

Cost of oil

It is a common axiom in the petrochemical business that there are two ingredients you need to make a success of the plastics business, the raw materials and a market. India has only a market. The US economy was, and still is, driven by access to cheap supplies of oil. India, on the other hand is an oil-poor country. Oil based feedstocks constitute about 30-40% of the cost of production of plastics (compared to labour at an estimated 3%).As the Rakesh Mohan Committee clearly states:

> 'One of the major issues which have dictated the world-wide growth of petrochemical industry, has been the availability of cheap feedstock. The feedstock position in India is rather complicated, considering the multifarious use to which the same feedstock can be put to. Undoubtedly, India is woefully short of petroleum products, (i.e. oil) which is its single largest component of imports.'

The 1997 figures from The Centre for Monitoring Indian Economy (CMIE) showed in the fiscal year 1996-7, 26% of the total value of India's imports (all commodities), the largest single item, was for POL (petroleum, oil and lubricants). According to a report in the Times

of India on 3rd March 2000, the Petroleum Ministry estimated that the oil import bill is expected to rise by 23% from Rs57,000 crore to Rs70,000 crore by 2002. This works out at about Rs700 per man woman and child in India per annum.

Cost of funding

As Mohan described, for both capital and operating costs, the petrochemical sector in India is highly capital intensive. It is therefore greatly affected by the cost of funding which is extremely high in India. In 1993 it was around 23% – almost twice the rate paid by competing economies in Asia, like Taiwan, Korea, Malaysia and Indonesia. In 1998 it was about 15.5 %. The target figures emphasised by the Rakesh Mohan Committee were between 10-13%: 'In general if the Indian industry is to be internationally competitive, with immediate effect, the lending rates both for term loan and working capital requirement must come down to levels of competing economies. Thus the term loan interest rate should be dropped to 10% and the working capital interest must be dropped to 13%.' [9, GOI Mohan]

The plastic processing industry is equally capital intensive. According to a paper presented by Reliance Industries Ltd at the end of the fiscal year 1994, the estimated investment in the plastic processing industry was US$1.3 billion. The status in March 1996 was US$1.548 billion, projected to rise to 1.8 billion by the end of 1997. By 2001-2, it is expected to reach US$4 billion. [52, Reliance Industries Ltd]

Cost of foreign capital

The infrastructure of the petrochemical industry in India – chemical engineering and nearly all technology and expertise –is acquired from foreign sources and has to be paid for in foreign currency or equity. The huge amounts of capital required for production and funding also has to be found overseas. It's a double burden.

> 'The petrochemical industry is necessarily capital intensive and projects normally involve a 25-30% Forex (Foreign exchange) component primarily for the import of capital goods, technology fees and training/expatriate expenses. The sourcing and servicing of this large foreign exchange resource can only be met fruitfully by a substantial foreign equity participation.' [9, GOI Mohan]

The 'liberalisation' policy of the Indian Government in the 1990's encouraged Foreign Direct Investment (FDI) in technology and expertise and not necessarily foreign ownership of Indian petrochemical companies. 'Approval is now (1993) being given for direct foreign investment up to 51% foreign equity in high priority areas which include heavy organic chemicals including petrochemicals.' The approval procedure for involvement of foreign companies in the Indian economy 'has also been eased'. [9, GOI Mohan] The sums involved are huge. For example, crackers to increase ethylene capacity can cost between Rs1500 and Rs2,000 crores (US$375 and 500 million). The gradual devaluation of the rupee – about 30% relative to the US dollar over the last few years – will escalate the estimates of 1993.

Consequently substantial profits from the domestic market will go abroad to service debt. The amounts are hard to establish accurately, secrets kept by Indian companies, in the files of the world's major petrochemical companies and with the Reserve Bank of India.

Cost of licensing technology

One area where foreign companies have been, and continue to be, essential to the growth of the petrochemical industry in India, is in the provision of technology. Licensing of technology has emerged as a major source of income for chemical Multi National Companies (MNCs). An OECD study of technology licensing found 'the chemical industry is by far the most common licensing industry in the sample'. With 24.6% of foreign licensing for chemicals, the next highest is machinery with 10.9% and drugs and medicine, 10.4%. The chemical industry also comes highest in technology transfer, involving 20% of joint ventures included in the survey, 21% of technology sales, 20% of technological services, 20% of turnkey plant provision, 19% of management contracts and 23% of other means of technology transfer. [63, Vickery]

Korgaonker noted for UNEP/ESCAP that the Indian Government has tended to prefer technical to financial involvement by MNCs. Not surprisingly, therefore, these technical collaborations or production under license by MNCs, led to an increased outflow of payments through royalties and technical fees etc. [64, Korgaonker]

Raising foreign capital for Reliance, IPCL and NOCIL

Reliance

Reliance Industries are now completing construction of their massive refinery at Jamnagar, a semi-desert coastal site in Gujarat. This will be the largest oil refinery in Asia, and possibly the worlds largest. It will refine 15 million tonnes of oil annually and includes its own port, jetty and captive power plant. Plans for the integrated refinery include the manufacture of 400,000 tonnes of polyethylene annually.

The total investment in the site is estimated at a staggering Rs20,400 crores (about US$5 billion). The refinery alone will cost Rs9,700 crores (US$2.42 billion). Of this Rs 5,000 crores (US$1.25 billion) will come from foreign currency (25%). Finance is obtained from the Industrial Credit and Investment Corporation of India (ICICI) or Reliance's lead institution, The Industrial Development Bank of India (IDBI). Apart from rupee loans of Rs2,400 crores from such institutions and banks, Reliance has successfully raised Rs700 crore through an IPO (Initial Public Offering) in the domestic market and US$400 million (Rs1,600 crore) through foreign exchange loans and foreign currency convertible bonds. [59, Business World]

In 1996/7 Reliance became the first corporate in Asia to issue bonds in the US debt markets with maturities of 100 as well as 50 years, the so-called 'Yankee bonds'. These issues were not only publicised in the financial press but in mainstream news sections – an expression of national pride in India's global business acumen. Reliance also issued bonds with 20 and 30-year maturities in the US debt markets. 'All these bonds are unsecured and have been raised without recourse to any guarantees from governments, banks and institutions.' [60, Reliance Industries]

IPCL

IPCL has also been successful in obtaining foreign capital. In October 1994 it announced that it had obtained a direct loan of US$46.4 million from the US Export Bank, the first ever such direct loan to an Indian corporate borrower. This formed the first tranche of a proposed US$132.2 million loan and would be used to finance the purchase of US capital goods for the company's Gandhar petrochemicals project. [61, ECN] In December 1994, IPCL began a two-week road show in the US aimed to draw in US$85 million. Goldman Sachs and Co led the IPCL stock offer internationally.

NOCIL

In June 1995 NOCIL announced plans to raise US$507 million in a rights issue in the last quarter of 1995. This finance was to go towards modernising and expanding its plant at Thane, near Mumbai. The International Finance Corporation (IFC), the commercial arm of the World Bank, agreed to syndicate the foreign exchange requirements of the project. [62, Financial Times]

The New Industrial Policy, as outlined by the Rakesh Mohan report, encouraged the removal of restrictive licences on common plastics. 'The major downstream items which no longer require licensing are: LDPE, HDPE, PP, PS, ABS. Automatic clearance is being given for import of capital goods being serviced by foreign exchange purchased from the market. Even import of second hand capital goods is presently being allowed in some sectors without the use of licensing procedures. All this is expected to bring down the cost of new projects.' [9, GOI Mohan]

An OECD survey found that the chemical industry tended to licence not only its current production technology, but also the previous generation. This sometimes coincides with the opportunity to sell an actual plant for which the industry is happy to obtain more than the scrap value of. British Petroleum (BP) was reported to be planning to sell its mothballed UK Baglan Bay cracker to a company that was interested in reconstructing it in South Asia. The 350,000 tpa cracker, ('cracking' crude oil into various other petroleum products) which had operated from the early 1970s, was shut down and mothballed in March 1984, due to a lack of competitiveness at a time of over-capacity in Europe. The cracker was expected to have a lifetime of 10-15 years. BP refused to comment on market rumours that the cracker had been sold to India. [65, ACN]

Other Indian companies rumoured to be importing second-hand plant include the Sardia Group which intend to manufacture 80,000 TPA of PVC resin at Haldia, West Bengal. While at Dahaj, Gujarat, Mardia Chemicals Ltd plans to import an aromatics plant previously owned by Mobil, which is currently located in Naples, Italy. [65, ACN] Among other examples cited by Asian Chemical News are the sale to SVC Superchem of a 21 year old PTA plant formerly owned by Rhone-Poulenc, to be relocated to Mathura in UP. And in June 1996, the purchase of a second-hand membrane cell chlor-alkali plant by DCM Shriram Consolidated Ltd from Norway. However, this tendency of MNCs to sell old petrochemical technology to India has proved the exception rather than the rule.

Cost of technology partnerships

The major Indian commodity plastic producers have formed partnerships with world leaders in specialist technologies. Chemplast, IPCL and Reliance have all depended on US company B. F.

Table 10 Licensing partners for some existing commodity plastic production facilities in India

Producers	Licenser	mta
Reliance Industries Ltd	BFG	160
Finolex Plastics	Hoechst	130
Indian Petrochemicals Corp. Ltd	BFG	55
Shriram Vinyl & Chem Industries	Sinetsu	33
Chemplast	BFG	50
DCW	Kureha	40
NOCIL	Shell	25

Source: Indian Chemical Markets Conference proceedings, March 1995

Goodrich (BFG now Geon) for technology and imports of raw materials, while the German giant Hoechst has partnered Finolex. [66, Dhuldhoya] Table 10 describes some of the licencing partners for Indian commodity plastic production facilities.

Reliance went into partnership with the Japanese company, Itochu, which reportedly invested US$50 million in two companies: Reliance Polyethylene, producing 160,000 tpa of PE, and Reliance Polypropylene, producing 250,000 tpa of PP. The Itochu investment was notable as the first major Japanese investment in India since the reforms of July 1991. Reliance's 350,000 tonnes polypropylene facility at Hazira uses highly efficient Unipol gas-phased polymerisation process from Union Carbide and Shell's widely acclaimed catalyst system. This will make it 'a global player in PP and one of the largest producers of PP in this part of the world'. [60, Reliance Industries] The huge Reliance Jamnagar project was being jointly project managed by US giant Bechtel. 'Reliance has a range of tie-ups with global leaders for know-how. Technology and licences for the main refinery come from UOP of the US; Black and Veatch provides technology for the sulphur recovery process; Linde for the hydrogen manufacturing facility; John Brown, Unipol for the polypropylene facility and Foster Wheeler for the coker facility.' [59, Business World]

Lack of Research and Development

The short and long-term costs of these partnerships are impossible to calculate. However, one cost is that India appears to be not investing in indigenous manpower and skill. Rather it is building a dependency on northern expertise.

Oman for the OECD has noted that, 'Many Indian observers consider that the Indian petrochemical industry is likely to remain highly dependent on foreign technology for some time to come. The forms of foreign involvement and transfer of mechanisms that were adopted, the conditions under which technology imports took place, and the failure to establish sufficient backwards linkages with engineering and equipment manufacturers all tended to perpetuate this dependence. Observers consider that even in recent joint ventures with foreign firms and their subsidiaries, there were no provisions to train indigenous personnel and give them the skills needed for efficient plant operation and maintenance'. [67, Oman]

Although growth in the primary, secondary and tertiary petrochemical industries is supposed to introduce new technologies, there is no empirical evidence about any major advance in the technological base of Indian industry. In fact the major advances have come from service industries; e.g. software production. 'The technology partnerships, so far, seem to be interested not in production but in control. ...It has attracted consumer goods production, investing in low technology goods, and does not add to the technological base of the economy.' [68, Diwan]

Rakesh Mohan highlighted that Research and Development (R&D) funding is very low in India. 'In the year 1990 developed countries accounted for 96% of the total expenditure of the R&D in the world. This figure was 95% in 1985 and 98% in 1990. Most of the developed countries devoted 2-3% of their GNP on R&D while India has spent 0.89% of GNP on R&D during 1990-1. India's per capita R&D expenditure was only a meagre US$ 2.76 compared to between US$ 100 and US$ 600 for most of the developed countries...It is quite evident from these figures that the (Indian) R&D expenditure is very meagre. Thus more funds should be made available for R&D.'

Reliance Industries Ltd

Analysts acknowledge that only two companies dominate the polymer industry in India. 'When people in India think of petrochemicals they inevitably think of just two companies: Reliance Industries Ltd and Indian Petrochemicals Corp Ltd (IPCL).' [69, Business World]

But it's fast becoming only one. In 1997, IPCL recorded a meagre sales growth of 3% and profits actually slipped by 44%. 'Indian

Petrochemicals Corporation Ltd (IPCL) has registered a 52% fall in net profit at Rs243.69 crore for the year ended March 31st 1998, as compared to Rs510 crore for the corresponding period last year.' [70, Economic Times] In the first quarter of the 1998 financial year, the picture worsened further and IPCL suffered a loss of Rs56 crore. By comparison, Reliance's net sales jumped by 57% to 6,330 crore (US$1.58 billion) and net profits by 29% to 840 crore (US$210 million). Or, as quoted in Business Standard, net sales up 54% and net profits up 25%. [71, Sharma]

Reliance Industries have a 56% share of the plastics market in India. Its market share in polyester and fibre intermediates is 45% and 85%, respectively. It is India's biggest private sector industrial company. In 1998 Reliance increased its production 26% as new plants at its Hazira complex came on stream. Sales volumes were also up 26%. [72, Guha]

It seems that the future of the petrochemical and therefore the plastic industry in India is being focused on this one company, Reliance Industries Limited. As we have already described, Reliance's figures potentially skew the total growth figures for the petrochemical industry in India. Without its success, the industry as a whole showed a negative growth of some 33%. 'We fear Reliance', says a Mumbai industrialist, 'because wherever it goes it destroys the competition.... In petrochemicals, companies like the public sector IPCL are today a faint shadow, their market shares gobbled up by the huge capacities that Reliance has built'. [73, Narayan]

The Godfathers

The present star chief executives, Mukesh and Anil Ambani, are sons of the founder, Dhirubhai Ambani. The Indian business community holds Reliance and the Ambani's in almost mystical awe.

> 'Reliance provokes extreme reactions in India. Either you are pro-Reliance or anti-Reliance. There is nothing in between. To many, God is a poor second cousin to Dhirubhai Ambani, the chairman of Reliance Industries Ltd. To others, the Ambani family typifies the seamy side of big business: fixing import quotas, pre-empting licences and switching share certificates. Amidst such extremes, public drama, recrimination and bitter controversies, RIL has built up huge capacities at extremely competitive costs and

become a force to reckon with in petrochemicals.' [74, Business India]

Mukesh and Anil Ambani attribute the success of Reliance to its flexibility, integrated facilities and state of the art technology. They can turn out whichever plastic the 'market demands' by investing in a 'swing reactor' that will manufacture either LLDPE or HDPE. They can chose which feedstock they use, depending on the best market price, having installed a multi-feed cracker. They are building refineries (for example at Jamnagar) to make their own feedstock, so becoming independent of government supplies and the vagaries of import tariffs. They have built their own captive power plant to be independent of the state electricity board.

Unencumbered by old plant, cramped sites and Indian bureaucracy, Reliance is modelled on American-style corporations, with similar global ambitions.

Mukesh Ambani interview in Business India

In a 1997 interview in Business India Mukesh Ambani said: 'Without flexibility in operations one cannot quickly respond to market conditions.' In Reliance's case, flexibility seems to be the holy word – be it in engineering, systems design or financial deal making. Consider just the production side. The polyethylene plant at Hazira has a swing reactor that can produce, with hardly any change, either high-density polyethylene (HDPE) or linear low-density polyethylene (LLDPE) according to market requirements. The cracker at Hazira is designed to use gas, liquefied natural gas, and naphtha or gas oil as feedstock. 'Since feedstock prices cannot be predicted, RIL has the flexibility to use whichever combination that increases our operating margins,' explains Mukesh Ambani. 'Considering the lifecycle cost of the cracker, the extra investment on a multi-feed cracker is marginal'.

'This agility translates to greater value addition. Earlier, RIL was spending US$1,300 on ethylene to produce about US$2,800 of products. Today, the cracker uses no more than US$600 worth of naphtha to produce the same end value. We hope to make a profit of Rs2,200-3,000 crore every year from Hazira alone. Even if global petrochemical prices fall by 10-15%, the high value addition at Hazira will sufficiently insulate RIL from such downturns. On top of it, our marketing costs are

extremely low .We spend US$3 per tonne for marketing US$800 of plastic. Our total distribution cost of plastics to any point in India is US$26 a tonne. Let anyone who wants to enter the Indian market beat that!'

'Our projections for the group in 1999-2000 are assets worth Rs30,000-35,000 crore and a turnover between Rs40,000-50,000 crore. If the administered pricing mechanism for petroleum is lifted and crude is 'decanalised', then with the way we have configured the Jamnagar refinery, Reliance will be globally competitive. Refineries of the future will be fully integrated with petrochemicals and power. We were the first in the world to think that way and the first to build such a refinery.

'After Jamnagar, we will grow upstream into oil and gas and energy. For that we might even have to go outside India, and have already bid for Iraq sites with ONGC Videsh. The new exploration policy itself will open up opportunities in India. If there is any oil in India then Reliance will definitely find it. Reliance will get listed on Wall Street because we want to benchmark ourselves with the top 100 companies of the world.'

The fact is that RIL has successfully withstood the pressures of 1996-97 – one of the most difficult and recession years for the petrochemical industry. Today, the company has world-class plants, integrated facilities and state-of-the-art technology. RIL also has one of the lowest employee costs (2.7% of sales), although the capital cost of newly set-up plants would be higher when compared to depreciated facilities of major global competitors. While RIL is diversifying into oil, gas, power and telecom, its mainstay in the next three to four years will be petrochemicals and polyester. [74, Business India]

Economies of scale

Reliance's strategy is bold. Instead of growing in step with market demand, Reliance set up huge over capacities, thus lowering costs, pre-empting others from expanding into the market and lowering prices for consumers. By relying heavily on volumes to sustain its growth momentum, they have thereby survived the slide of international prices. Volumes shot up by an incredible 78%. 'Production in the first half (of

1997) is equal to the whole of last year's production.' [74, Business India] By encouraging over capacity, government strategy has played into the hands of Reliance Industries. Stock market operator, Harshad Mehta provides a key in the following analysis:

> 'This is what Reliance's and Dhirubhai's biographers down the years will study clinically and confirm as his mark of genius. The daring ability to commission capacities far in excess of what the market could take at that moment of time. I call it the contra-MNC approach. The MNC approach would have been that of growing in step with the market after ascertaining precisely the growth in the consumption pattern or industry. Reliance demolished this model. It set up huge capacities, whereas normal logic would have dictated that production be tailor-made as per emerging demand. Reliance again took the contrarian route. It produced as much as possible – in most instances above its capacity.
>
> 'Why you may ask? Because through this business strategy Reliance did a few important things: it lowered its cost, it pre-empted others from entering in the face of a huge over-capacity and most importantly, it widened the market by pricing more attractively from a consumer's point of view. Result: as the market grew, courtesy of this competitive pricing, Reliance started running out of capacity. So it commissioned expansions faster than the growth of the market and once again used the over-capacity and its huge economies of scale to price more competitively, commissioning these expansions at a cost lower than that of the others. So it wasn't volumes that were the key, margins entered the play as well.' [75, Mehta]

Reliance has even started to reduce import dependency of some polymers. 'Imports of Polypropylene (PP) in 1996-7 at 2,125 lakh tonnes were close to half the total demand. But Reliance with a new capacity of 2.7 lakh tpa, captured a major proportion of the market. This reduced imports to a mere 18% of the consumption. In polyethylene (PE) import substitution has again worked in favour of Reliance. In LLDPE too, imports are down by over 14% compared to 1996-7. In the PVC segment, the total sales have actually shrunk

by 10.2%. At the same time volume sales by Reliance have risen by 42%, largely at the expense of other industry players like DCW and Chemplast.' [76, Saxena] The huge over-capacity being created by Reliance may put their weaker competitors to the wall leaving Reliance in a near monopolistic situation, able to control prices.

However, Reliance's position in the Indian capital market (the Mumbai, BSE Sensex index) was weak in1998.

> 'Reliance's return on capital employed (ROCE) has been low. In 1996-7, it was 10.3%: going up to 13.1% in 1997-8. But at 15-16%, its cost of capital is high. The problem is if you are in a commodity business, there are only two ways that earnings can rise – either the commodity price increases or the capacity of the producer goes up. Only capacity and not price is under the producer's control. So Reliance has been increasing its scale of operations. This has worked in that the company's earnings have been growing. But the backlash on this volumes game has been on its ROCE. The global slump in petrochemicals hasn't helped. So far Reliance offset this with volumes. That may no longer be possible. Last year, for instance, sales grew 54% and post-tax profit 25%. But the first half of the current fiscal saw a sales growth of only 16.5% and net growth of 9.64%, despite the fact that Reliance had the benefit of fully using its new capacities at Hazira. Things could get worse. Already there is news of new capacities in some Asian markets. That could spell trouble for petrochemical majors like Reliance.' [73, Narayan]

Even Reliance faced problems as a result of the 'Asian economic shock'. More than a dozen ongoing projects were derailed and as a result 'financiers would be extremely careful before financing petrochemical projects'. [55, Financial Express] In January 1999 it was reported that because of over-capacity in Asia, Reliance was forced to drop the price of PVC by Rs7,200 to Rs24,000 per tonne. Despite its increase in production of 25% in 1998, average product prices fell 17% and revenue rose by only 9%. [72, Guha]

To protect it from the vagaries of a cyclical petrochemical industry, and therefore price fluctuations, Reliance, along with many

of the world's petrochemical majors, is diversifying into other industrial sectors, such as power, telecommunications, infrastructure and food, industries that are not so cyclic and ensure more stable streams of income. Up until 1999 Reliance has been ploughing back its cash flow to finance its petrochemical expansion, but now its Jamnagar operations are complete it can further diversify.

The need to create markets

Reliance has not focused on exports. Its interest has been in the domestic market. Reliance Vice-Chairman, Kamal Nanavaty, described Reliance's plastic exports on the open global market as mainly a price and quality benchmark – the internal market was 95% of their focus, and the 5% on the open market was to show competitive quality and price.

To maintain its cash flow and soak up its huge capacity for petrochemicals, Reliance has to continually find new markets for its petrochemical goods. It has to create rather than serve needs. By creating huge volumes it can lower margins so as to compete successfully with its petrochemical competitors in India and other against materials that can be replaced by plastics.

Reliance continues to grow as the smaller players become diminished. In November 1999 the President of the Indian Plastic Federation N K Tibrewala contended that, 'the steep price hikes of the basic raw materials have compelled 55% of small and medium units to work at only 40% of their installed capacity'. [77, Das] Meanwhile, 'aided by better volumes petrochemical major Reliance Industries reported a marginal growth in net profits to Rs1,704 crores for 1998-99 from the last year's figure of Rs1,653 crores.' Anil Ambani, presenting Reliance's annual company report noted that now, 'our cash flows would be higher as capital expenditure is behind us. The cash flows would now be used for value addition, acquisitions, reduction of net debt and distribution to stockholders'. There was even a hint that Reliance was contemplating taking-over IPCL. Regarding Indian Petrochemicals Ltd. Ambani observed, 'that Reliance Industries would examine the pros and cons when the government decides to divest in that public sector undertaking'. [78, Hindustan Times]

The one success of the petrochemical planners was to smooth the growth path for Reliance Industries. By building huge over-capacity, Reliance has managed to squash domestic competition. To finance their

ambitious diversification into infrastructure development projects and telecommunications they are attempting to greatly expand the domestic market for plastic. This means that they need to replace in India as many products that they can that are made from renewable bio-based materials with plastic substitutes.

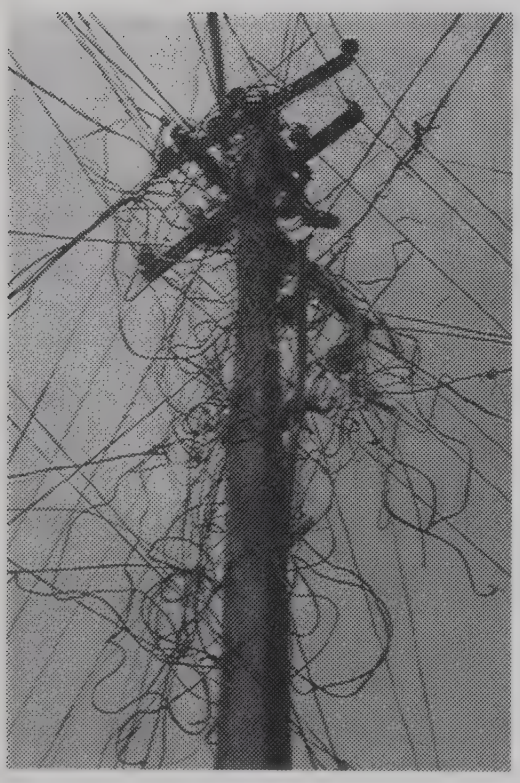
> 'Reliance has over the years, developed a strong distribution network for reaching its large and geographically diverse customer base, which gives the company a strong foothold in the market against domestic and international competition. In some of its products, Reliance has the capability to deliver the specified product within 24 hours at the customer's doorstep anywhere in the country.' [60, Reliance Industries]

For Reliance Industries, life in plastic is fantastic.

5 'Essential necessities'

'It is opined that petrochemicals lead to production of luxury goods of conspicuous consumption. In essence it has been proven beyond doubt that petrochemical products lead to production of consumer durables and agricultural inputs which are essential necessities for the entire population.'

Government of India, Rakesh Mohan Experts Group Report on Petrochemicals, 1993



The Government of India conventionally uses the expression 'essential necessities' to mean the needs of its citizens for the five human basics – roti, kapda, makan, swastha and shikhsa (food, clothing, shelter, health and education). The Indian petrochemical industry claims that it provides materials that serve these needs, as well contribute generally to the 'trickle-down' effect by means of the wider economic activity it generates.

Professor Barry Commoner thought the petrochemical industry tended 'not so much to serve social needs as to invent them, just to keep oil flowing from well-head to extrusion machine'. He used the image of a house of plastic cards soon to collapse in a mess of debris and toxic waste as oil reserves ran dry. [29, Meikle]

The petrochemical products prioritised for manufacture by the various government reports are in the sectors of telecommunications, agriculture and construction. Yet over 50% of all plastics produced in India are destined for packaging. A product conceived as waste. High growth areas are projected for polystyrene in all forms of disposable packaging, blister packaging and toys. 'The concept of disposable

packaging in India is in its nascent stage. With the entry of fast food chains such as Macdonald's, Pizza Hut, etc the growth in demand for PS arising from this sector shows a good potential'. [79, Ram] Other commodity plastics used for a variety of packaging are: milk pouches made of LDPE; beverage containers made of PET; PVC used for shrink-wrap; woven PP sacks for cement, sugar and other commodities. The ubiquitous plastic carry bag is usually manufactured from polyethylene.

Plastic packaging enables the movement of goods from their point of manufacture out into the global markets, by encasing, protecting and sometimes preserving the product. These global markets effectively undermine small-scale local markets. The issue of the shift of the locus of economic power from communities and local (including regional and national) economies to the large corporations is what now dominates the current reality of the global economy. Increased use of plastics in packaging agricultural commodities, especially processed foods, will aid the conversion of agriculture to cash crops and strengthen the power of MNCs. In a local agricultural economy the season's harvest would be consumed at source whereas with plastics, food can be transported greater distances, to other markets, often the supermarket shelves of the north. This requires added infrastructure – more trucks, better roads, and flights across continents – all of it adding to resource depletion and environmental pollution. Looking at how this process has affected the north, there are a multitude of examples of wasteful uses of resources. Take just one: 'Britain will this year (1999) export 111 million litres of milk and 47 million kilograms of butter, while simultaneously importing 173 million litres of milk and 49 million kilograms of butter'. [80, Norberg-Hodge]

Consumer durables

In India, as in other semi-protected and 'closed' economies, imported displays of plastic luxury goods have become indicators of material success. Today plastic goods manufactured in India feature strongly in new consumer market places. The Indian middle-classes 'want' the same goods enjoyed in the north. In many of these products – 'pucca' houses (with PVC windows, flooring and pipes), cars and scooters, music and video systems, refrigerators and washing machines, televisions and telephones – plastic is an 'essential' ingredient.

That the promotion of certain commodity plastics leads to 'conspicuous consumption' is an inevitability when volumes have to be pushed, as in the case of Reliance Industries. Nowadays markets and needs are created. Necessities are being sought, mainly by the burgeoning middle-classes, which once they did not even know existed. For the poor, this is 'a mandatory but inaccessible model of the only real way to live'. [2, Berthoud] The needs, particularly for plastic products, are therefore often defined not by the 'needy', but by those who manufacture the needs. This is clearly seen throughout the history of plastics, in the north and now in India. Defining the requirements of people is a complex subject, but there is clearly a difference between wants and needs, just as there are two different words. However, 'market forces' aim to persuade us that there is no difference.

Indian market studies indicate that, 'The demand for consumer durables especially televisions, audio systems and refrigerators is likely to grow at around 15-18% per annum over the next few years. This growth is mainly contributed by the rising middle classes, the entry of Multi National Companies (MNCs) and introduction of newer products in the market'. [53, Ram] The largest market segment for polystyrene is audiocassettes, as described in Table 4.

Vital sectors

There are certain applications for which plastics, as the material of choice, appear vital. These are markets where plastic has marked a 'true innovation', for example their many uses in the 20th century media revolution. It could be argued that high tensile and specialised plastics have enabled these revolutions. The first question here is *which* plastic and the bigger question, *what 'need'?*

The government planning process for the petrochemical industry identified three sectors where plastics will play a major part in its 'first track' economic strategy of investment and modernisation – power and telecommunications, agriculture and construction.

> 'The consumption trends and growth potential of commodity plastics can be better understood if we look into the end use analysis of these polymers. Polymers find diverse uses in various sectors of economy due to their excellent substitutability, functional superiority, easy

processability and their energy and cost effective nature. They find extensive use in packaging of industrial/ consumer products, agriculture, electronics, telecommunications, power, household items, etc.' [9, GOI Mohan]

Power and telecommunication

Plastics are an inevitable part of expanding and improving telecommunications and energy networks throughout India. These large-scale networks are a necessity in a global economy predicated on growth, consumption and the long-distance transport of data and commodities.

Rs100 BILLION BUSINESS ON THE NET IN TWO YEARS

An explosion of Indian web sites has seen Internet usage in Indian cities jump 20% since the beginning of 1999. The Business Standard quoted Amitabh Kumar, director of India's largest Internet service provider, Videsh Sanchar Nigam Ltd (VSNL), as saying 8,000 to 10,000 new people subscribed to the Internet every month. About 60% of VSNL's customers use the service for overseas access, while the rest of the Internet traffic is between Indian cities. According to industry experts, the number of Internet users in India will explode to two million over the next two years from the current level of 250,000.

The National Association of Software and Service Companies (Nasscom), estimates that India's electronic commerce transactions for the year ending March 31, 1999 was about Rs1.4 billion (33 million dollars). However, analysts say that if the telephone network is strengthened and more people have computers, India could generate Rs100 billion worth of business on the net in two years. India's telephone network has 20 million lines for a population of nearly one billion. Some 2.4 million Indians are in the queue for a phone connection. State-owned VSNL has set itself the target of installing 500,000 Internet connections by next year. [81, Noronha]

World-wide communication facilities make it possible to transmit the world-view of consumerism – via the web, movies, television programmes and direct advertising – thereby helping to homogenise diverse populations into masses of similar consumers with similar

desires. With television programmes like Dallas and Baywatch broadcast throughout the south, for example, people's distorted impression of modern urban life – fast glamorous, exciting, wealthy beyond measure – leaves them vulnerable to the often false promises of northern-style 'development', and hungry for the consumer products that seem to define modern life. 'Once television is there', the CEO of a large American MNC pointed out, 'people of whatever shade, culture or origin want roughly the same things'. [10, Gorelick] However, these same data networks enable a growing freedom of information, a freedom to potentially transform a system.

Leaving 'needs' aside and the benefits or otherwise of the telecommunications revolution, the first question is which material? Since this revolution has been enabled by commodity and specialised 'engineering' plastics – wiring and cabling, telephone handsets, insulators and conductors and a multitude of electronic components – traditional materials have never been used for this market. So which plastic?

Indian PVC power cables

Indian power cables are an important market for the PVC industry. The installed capacity of power plants in India was estimated at around 79,000 MW in 1996. By the end of the century, PVC industry spokesperson N.M Dhuldhoya estimated a further 30,000 MW of additional capacity is expected to come up. To distribute this power the estimated power cable requirement is 62,000 km, which will increase to 108,000 kms by the year 2000. [66, Dhuldhoya]

In India, PVC is the plastic used in applications such as insulation, and sheathing power cables, electrical and telecom conduits, flexible wires, and control cables. PVC is the most environmentally unsound of all commodity plastics, in its manufacture, use and disposal. In northern countries PVC is only considered the best choice because it is cheap. It is not the best choice for safety or insurance purposes, because toxic gases, such as hydrochloric acid and dioxin, are released when PVC burns.

Countries like Japan have recently become aware of the threat to the environment and human health posed by PVC through its production processes, use and disposal, and are now starting to manufacture substitute plastics for power and telecom applications.

JAPAN STOPS USING PVC CABLES

The biggest electric cable manufacturer in Japan, Sumitomo Electric Industry, announced on 25th May 1998 that they would ban PVC for general electric cables. They will start to sell non-PVC cables and all of the generic cable covers will be replaced with non-PVC materials in about five years. Sharp Co, one of the biggest home appliance manufacturers in Japan, announced they would get out of PVC in 1998. Ricoh Co is also aiming to cease using PVC covered wire by 2000. In its place, polyolefin resin-covered wire will be adopted. Decisions to stop using PVC arose in Japan because of fears of dioxin formation, one of the most toxic synthetic chemical compounds, from PVC production and disposal, the costs of recycling PVC and the use of lead, which is incorporated in PVC resin as a stabiliser.

Agriculture

The plastics industry promotes a number of uses for plastics in agriculture. Table 11 lists the major uses of plastic in agriculture - the largest by volume being for water management.

Plastic piping, often PVC but increasingly HDPE, has a key use in water sprinkling and drip irrigation. In marginal semi-arid regions plastic piping can effectively help conserve and manage water supplies. However, some concern has been expressed that plastic piping used for irrigation will prove costlier in the long term because plastic, unlike metal or bamboo pipes, is not easily repairable. Bamboo, on the other hand, offers a sustainable alternative for irrigation. It can be easily repaired, its source is plentiful.

Polyethylene is used to line canals and ponds to prevent seepage. Environmentalist and agriculture expert Devinder Sharma thinks plastics have a valuable role to play in conserving water in canals. Brick linings are enormously expensive and clay often does not last. [83, Sharma] However, he feels that, overall, the emphasis placed by industry on the role of plastics in agriculture is exaggerated. For example, plastics are increasingly being promoted for mulching but traditional methods of using straw and agricultural wastes are perfectly adequate, involve less dependence on uncertain technology, and avoid extra expense for farmers.

Table 11 Consumption of plastics for agriculture in India

Sector	Application	Plastic consumption (tpa)
Water management	Pipes and fittings	77,000
Agriculture	Canal and pond lining	3,000
	Drip irrigation/greenhouse/ low tunnel/mulching	1,000
	Food-grain storage	8,000
	Packaging	65,000
Dairy	Milk packaging	25,000
Forestry	Nursery bags/rain guards	20,500
Total		200,500

Source: [82, Economic Times]

Government agriculture policy has favoured high-value, capital intensive 'Green Revolution' technology in which plastic plays an important part. Recent government policy apparently earmarks already irrigated areas for the cultivation of high-value production of fruits, flowers and vegetables for the agro-processing industry and for exports. Plastic tunnels, plastic mulching, plastic greenhouses and plastic drip irrigation are being promoted as an enabling technology for this high-value business. Government has aided the spread of drip fed agriculture by 'enhancing the subsidy on sprinkler and irrigation from 50% to 70% of the cost of the system and the ceiling is also being raised from Rs15,000 to Rs20,000 per hectare'. The same budget also aimed, 'to promote investment in commercial or high technology agriculture and allied activities such as horticulture, floriculture and agro-processing'. [44, GOI]

Plastic aided drip irrigation systems are only beneficial for growing high-value crops because of the required high investment, lower life span and high maintenance costs. Such drip irrigation systems have their problems. 'Laterals' are prone to attack by rodents and must be replaced frequently. [84, Laddha] According to Devinder Sharma, plastic greenhouses, ponds and irrigation systems for intensive aqua and floriculture potentially encourage disease, which leads to increased pesticide use.

The ever-increasing emphasis on using fertile lands for cash crops and high-value exports undermines Indian traditional sustainability and threatens India's internal food self-sufficiency.

> 'While there has been an explosion in groundwater extracting mechanisms and surface water irrigation

projects, a variety of local-level traditional water harvesting mechanisms adapted to varying ecological conditions have been allowed to languish.' [19, Tata Energy Research Institute]

Plastics promote cash crops

Even though the need to grow sufficient food for India's growing population is of vital concern, this is best achieved by moving away from intensive cash crops which deplete the soil by using increasing amounts of fertilisers and biocides and returning to sustainable traditional methods. 'Over 70% of the 40 million farmers in India fall in the category of small and marginal farmers with land holdings averaging a mere 0.2 hectares.' [83, Sharma] 'The vast majority of farmers in India who cultivate small plots of land are driven by the desire to produce for subsistence rather than profit alone. Over thousands of years they have developed a system of agriculture that makes the most of the locally available resources in terms of seeds, organic fertilisers, soil moisture and natural pest management.' Plastics have little part in this process. [85, Nellithanam]

Construction

Indian plastic promoters often say that with plastics 'the dream of a home for everybody can be translated into reality' – reminiscent of US dreams in the 1950s. [86, Hindu]

The Indian plastics industry is aggressively marketing plastic as a replacement for traditional materials in construction. Over 20% of total plastics production (around 1.5 million tonnes) is consumed by building applications. [87, Times of India] However, one plastic material PVC will probably not increase its market to the levels in the north, where some 60% of all PVC manufactured is used in building applications. PVC breaks down when exposed to strong sunlight and is therefore not suitable in India's tropical and sub-tropical climates for external applications such as pipes and guttering.

Inevitably, plastics are used for cabling and wiring, pipes and ducts, water storage tanks and cisterns. The polymer industry is now marketing doors, shutters, partitions, panelling and window frames but these have yet to become widely available. One new product,

double glazed windows in PVC frames, made by water tank manufacturer Sintex, has been criticised by consumers because of poor quality gaskets, painting work and no use of sealant. [88, The Pioneer]

Architect, Gerard da Cunha, who runs a successful national practice from his office in Goa, believes in using natural materials – stone, clay, ceramics, wood etc – that are abundant in India. However, in his experience, architects are bound by conventional market recommendations. Often materials choice is decided by the builder and not the architect and neither is confident enough to improvise as would traditional communities. Some builders choose plastic pipes, while others distrust the new plastic materials, fearing breakdowns in underground pipes, and always specify metal or concrete pipes. Increasingly, as in the north, materials are chosen because a government standard has dictated them. For piping and other applications the standard directed material is mainly plastic, and often PVC. [89, da Cunha]

As plastic is being promoted in mainstream construction projects, a number of non governmental organisations (NGOs) and individuals are successfully using renewable and local materials throughout India. The TARAGRAM off-shoot of Development Alternatives, a Delhi NGO, promotes the use of local building materials and energy generation. Englishman Laurie Baker has inspired many people with his well known buildings in mud and other renewable materials in Kerala. The Centre of Science for Villages (CSV) develops low cost housing using clay cones and sun-dried mud blocks. Bhakti Kutir is a successful tourist village of 18 huts made of bamboo, coconut wood vegetable dyed jute fabrics and rice stalk for thatch among the coconut trees of Palolem, South Goa.

Plastic values

Whereas plastics may be vital for power generation, for certain high-value agricultural products, for telecommunications etc - are all these infrastructure developments essential necessities for India? Survival is certainly possible without plastics: basic material needs - food, clothing, and shelter - can be met by using other materials.

Government planners who claim that consumer durables are essential necessities for the entire population are operating from a set

of values based on a series of assumptions about lifestyles and aspirations. Materials, too, have values. Plastics embody a set of values quite different from materials that come from a vernacular origin. While some plastics - for example, shoes, containers and toys - directly substitute traditional materials, other plastics enable entire processes. Take the example of power, which could not exist without plastics. Power *is* an essential necessity for industry, urban dwellers, fridge-freezers, air conditioners etc. But it also enables the creation of ever more unessential material goods. Take high-value agricultural products, which could not be produced, packaged and transported without plastics. Is this an essential necessity or an affordable want. For the majority of Indians, these high cost crops are not essential or obtainable.

The values that come with plastics are not necessarily the values of the majority of Indians. Nor are they sustainable in the long term. Plastics are an integral part of the movement towards a global culture dominated by an economic *necessity* that demands an ever-increasing consumption of material goods. The essential necessity of plastic is that it becomes an essential necessity.

6 Resource depletion

'There are extensive campaigns against plastic, but one should recognise that it helps conserve natural resources'.

Union Minister of State for Chemicals and Fertilisers, A K Patel, December 4th 1998

'Resource depletion' is a major and often repeated reason for promoting the replacement of traditional products by petrochemical products. The hypothesis constantly put forward by industry and its allies in government is that certain natural and mineral resources already in short supply in India are becoming scarcer as the population increases. Plastic products, declare government and industry, will readily cater for needs as supplies of traditional materials dwindle, and thereby help conserve the environment and its resources. 'With the depletion of natural resources which is under pressure from ever increasing population, petrochemicals become the inevitable source of all such need.' [9, GOI Mohan]

There is a fundamental irony in this argument - the base material of plastics, oil, is also a 'natural resource' that the government seems determined not to 'conserve'. Not only is it a natural resource, it is also a finite resource, whereas traditional materials, such as wood and bamboo, are renewable.

Certainly many traditional materials are now depleted. Apart from wood, clay is also in short supply as urbanisation is removing many clay sources and thus threatening the livelihood of potters. Plastic is also replacing materials such as steel and cement, both of which

are plentiful – currently the cement industry is suffering a major fall in demand. Cement holdings of the major industrial conglomerate B. K. Birla are mounting losses and the group is considering ditching their cement subsidiaries. [91, Economic Times]

Wood

Forest depletion is a serious problem for India, and one of the key reasons for promoting plastics. The Bhattacharya report states that, 'India's annual timber requirement is almost 27 million cubic meters. This converts into a major problem as the growing stock is only 65 cubic/meters per hectare compared to 110 cubic meters per hectare for the rest of the world'. [43, GOI Bhattacharya] Not only government but the plastic industry is understandably keen to exploit the ability of plastics to substitute wood. 'Due to our chronic shortage of wood, which in any case we should avoid to save our forests so very essential for our ecology, windows and doors should now be made of plastics.' [11, Sharma]

India has a closed forest cover of about 20% of land area whereas an estimated 30% is needed to grow wood for commercial, social and ecological requirements. Without question by 'ignoring' forests, replacing some of their vital uses by plastics, forests will further degrade. *It is only by effective forest management and judicious farming that they will be preserved.* Effective forest management can provide for both timber uses that plastics threaten to replace and for the needs of forest dwellers as well as maintain India's rich and invaluable bio-diversity. The key to this transformation is empowerment of forest-based communities to own, manage and economically benefit from the full value of forests. This includes making markets available for 'value-added' forest products such as furniture, doors and window-frames that plastic threatens to dominate.

The area of land required for forestry products – including timber for construction, pulp wood for paper manufacture, firewood for villagers and an adequate area to protect the bio-diversity of animal species – is an estimated 70 million hectares (mh). According to the Centre for Science and the Environment (CSE), there is about 170 mh of degraded land suitable for growing trees in India. [92, Roychowdhury] The Tata Energy Research Centre 'estimate that the current annual growth in forests is only 88 million cubic metres,

whereas, potentially, it could be as high as 139–235 million cubic metres'. [19, Tata Energy Research Institute] Enough potential land to grow trees to satisfy needs.

Forestry policy

In developing countries, the usual reason for deforestation is the growing need for agricultural land and the spread of towns. But in India, at least for the last thirty years, the main cause of forest degradation has been the alienation of large areas of forest lands from the people living in and off them. Consequently pressure on the remaining forests for grazing and livelihood has turned them into open access. The seeds of this situation, as with so many other social and environmental ills of India, were sown during British colonial rule. [93, Saxena]

Colonial Rule: Reserved Forests and Protected forests

Until the last century India was covered with thick forestland. From the beginning of the nineteenth century British rulers ordered the systematic felling of large areas of virgin Indian forest mainly to meet the ever-expanding needs of the British shipbuilding industry. From 1853 the building of the railway in India required further vast amounts of timber for sleepers and fuelling locomotives. Later when coal replaced timber as a fuel; the coalmines themselves needed large quantities of timber for their underground galleries. Exploitation continued and during the 2nd World War when 6,326 square miles of previously untouched Indian forests were felled for the war effort. [94, Ministry of Agriculture]

To meet the Empire's needs during the nineteenth century the forests were gradually nationalised. Forests were divided by the British into two broad categories: Reserved Forests and Protected Forests. Reserved Forests were exclusively for the use of the Forest Department and the surrounding villages had no rights, other than the ones explicitly permitted by the state. The Protected Forests were also managed by the Forest Department, but the people had certain rights to them, such as gathering fruits and other produce of the trees, grazing livestock, hunting wild animals and cutting wood specifically for household use, but not for sale.

The first forest policy after Independence, was the Forest Policy of 1952. Although it promoted conservation, it declared that village communities should not be allowed to use forests at the cost of 'national interest', which was defined as defence, communications and vital industries. Forests were almost exclusively used for increasing the revenue for the state, producing timber for industries, railways, exports and for defence needs.

This policy was radically altered by the publication of a National Forest Policy (NFP) in 1988. Forests were not to be commercially exploited for industries but were to conserve soil and water and meet the subsistence requirements of the local people. It discouraged monocultures and promoted mixed forests. The focus shifted from 'commerce and investment' to ecology and satisfying minimum needs of the people, providing fuel-wood and fodder and strengthening the tribal forest linkages.

However, the NFP was soon challenged. Amendments to the Forest Conservation Act in 1988 banned assignment or lease of forest lands to the people and prohibited plantation of horticultural crops, palms, oil-bearing and medicinal plants on forest lands *unless prior permission of the Government of India* has been taken. The amendment thus nullified the entire concept of village forests provided for in the NFP. The government clearly wanted to continue to hold exclusive monopoly rights to management and ownership of forestlands, especially Reserved Forests.

In a report, CSE argues that India continues to follow the British laws, which, by retaining central control, have destroyed the traditional systems of village management. Today the government owns nearly one third of India's land and all its water resources. Forest village communities, not surprisingly, have lost interest in management or protection of forests. Having realised that the main objective of government management has been to meet urban/industrial needs, they have often exploited resources without a care for the future. While local communities can be the best protectors of their natural surroundings, they can also be the worst destroyers if there are no stakes involved. [95, Kothari et al]

This downward spiral has led to massive denudation of forests, over-exploitation of grazing lands and neglect of local water systems. This will only change, CSE say, if we can give forest people a stake

in the improvement of the natural resource base by reversing the current legal structure of control over natural resources. [96, Agarwal]

Effective farm forestry

CSE proposes that the timber and pulp industries resource their raw material needs from decentralised farm forestry. A forest based industry would meet India's raw material needs by encouraging farmers, particularly small and marginal farmers, to grow wood on marginal/degraded lands. If industries, particularly the pulp and paper industry, source supplies from their own captive plantations, then smaller farmers will be denied a market, and why should they then plant and maintain forests?

The importation of pulp has further undermined local markets for farm forestry. In the 1980s, despite the continued promotion of farm forestry, the government allowed cheap imports of pulp 'in order to save Indian forests'. Instead of saving forests, it destroyed them. Companies found it cheaper to buy pulp from Canada than buy from Indian farmers. The bottom fell out of the pulpwood market and farmers literally plucked-out their plants in several parts of India, especially in Punjab, Haryana and Gujarat. Of the 10 billion trees that were planted on farms between 1980 and 1988, the output of wood from government forests never crossed the 10 million tonnes - it should have been 25 million tonnes.

Government needs to actively support the market for wood grown on degraded lands, or at least make sure that there is a level economic playing field. Promoting plastics for window-frames, doors, construction and furniture acts as a further disincentive for farmers, forest dwellers and rural craft persons. Vanishing forests and the lack of an effective policy to replace them have caused many of India's 14.8 lakh woodworkers (1981 census) to hang up their tools of trade. [97, CSE]

Initiatives like Joint Forest Management (JFM), that effectively involve the local community as stakeholders, need to be the basis of forestry policy. 'The present alienation and indifference of the local communities towards the 'government forests' can be dissolved if they themselves become the prime recipients of the benefits accruing from conservation.' [95, Kothari et al]

Policies should reflect ancient Hindu culture rather than colonial British policies, and allow for a mix of commercial, social and ecological uses for forests.

Hindu categories of forests: shrivan, tapovan and mahavana

In Hindu philosophy the whole world is a forest. In the sacred text, Bhagavad Gita, Krishna compares the world to a single Banyan tree with unlimited branches in which all the species of animals, humans and demi-gods wander. Hindu tradition describes three basic categories of forest. One is *shrivan*, the forest that provides your prosperity. Then there is *tapovan*, where you can contemplate as the sages did and seek after truth. The third is *mahavana* – the great natural forest where all species of life find shelter. In Hindu philosophy, each of these categories must be preserved. [98, Banwari]

If some of the original forest was cleared, Vedic culture required that another forest be established in its place. To remove the forest was simply not acceptable. The shrivan was the source of natural wealth such as fodder, timber, roots and herbs. Moreover the trees guaranteed the fertility of the soil and purified the air and water. Therefore the villages each preserved sections of forest for their own specific needs. [99, WWF]

CSE points to the example of Sukhomajri, a village in Haryana, which, in 1976, introduced a Joint Forest Management programme. The inhabitants of Sukhomajri have protected the heavily degraded forestland that lies within the catchment of their minor irrigation tanks. In return for state investment in an extra four tanks to hold water, the villagers accepted responsibility to protect the watershed. The tanks have helped increase their crop production by about three times and protection of the forest area has greatly increased grass and fodder availability. This in turn has increased milk production.

The Sukhomajri success story

A village level institution specifically created in Sukhomajri was crucial for the project's success. This institution, called the Hill Resources Management Society, consists of one member of each household in the village. Its job is to provide a forum for the villagers to discuss their problems, mobilise them to take control over their environment and ensure discipline among its members. The society makes sure that no household grazes its animals in the watershed. It has created a framework for a fair distribution of the resources so generated – namely, water, wood and grass – among the households in the village.

By allowing natural regeneration of their 400 hectares of khair forest the community has the potential to reap over Rs50 lakh from timber sales alone. By 1994 the 83 households in the village had replaced their thatch-and-mud dwellings with cement and brick houses and about 40 of them owned television sets. One villager commented, 'who could imagine that tractors and bicycles could be had for mere grass and water'. [100, Roychowdhury]

Lessons in control

Where successful projects have emerged through devolving management to the village level, the current political system and its administrators seem determined to interfere and destroy this sustainable progress. CSE, who followed the story of Sukhomajri from the beginning, has recently documented its present downfall.

> 'In 1995, in what can be termed a brutal stroke, the forest department arbitrarily divided the 400 hectare hill tract between Sukhomajri and its neighbour village Dhamala. Residents of Sukhomajri were no longer allowed to collect fodder from the area demarcated to Dhamala. The Dhamala village consists of upper caste Jats who had influenced the forest department to divide the forest so that they could grab nearly 80% of the grass that fell in their part of the forest. The Jats, by getting a lion's share of the forest, could stymie the Gujars of Sukhomajri who were the ones who actually raised the quantity and quality of the grasses.'[101, Mahapatra]

The government has also taken its 'pound of flesh' from the profits created by the Gujar community in Sukhomajri. Taxation now takes all but 45% of the money earned by the community. The government takes 75% of net profits for regenerated timber, after first deducting its costs of logging the forest. 'The department is clearly squeezing money out of the villagers and acting like an extremely rapacious landlord.'

Congress State Minister, Digvijay Singh, secured a victory against all odds in the November 1998 elections because of the successful watershed management project he had overseen in the district of Jabhua, Madhya Pradesh. According to CSE, the tribals acknowledged with their votes Digvijay Singh's key role in the creation of the project, which transformed a moonscape of drought and desolation, covering about 1% of India's land area, into a green landscape of trees and overflowing dug-wells.

> 'Jabhua's future looks very promising. This is just the start of an ecological change that could result in a massive economic change. With increased grass production, villagers can move to improved animal-based activities and milk production. Increased water will give them improved and stable agricultural production. Increased trees, depending on the type that are planted or regenerated, can give them both some short term income through sales of fruit, bamboo and other minor forest produce, and ultimately long-term income from timber. If managed intelligently, the availability of these raw materials can generate secondary economic activity like small-scale industries.' [102, Agarwal]

In most rural development schemes in India, money pumped down from the top is skimmed off by various layers of officialdom and political cronies until very little remains to help the intended people. The Jabhua regeneration programme was successful because it avoided this common pitfall by giving power and therefore responsibility directly to the people. A complex administration system involved all sections of society – from the state through district to village levels. Consultation has been comprehensive and decisions made from the bottom-up, by collectives and specific interest groups, including self-help groups, user groups and women's groups. One of the more interesting lessons from this case, is the reward by the local tribal

people at the ballot box, confirming that actions can speak louder than bribes, and long-term benefits bring greater political rewards than short-term sweeteners.

Bamboo

Bamboo is another biomaterial with a potential multitude of uses: for housing, for pipes to transport water, for furniture, scaffolding and handicrafts. China has already copyrighted 2,000 bamboo products under the new international Intellectual Property Rights regime. The Japanese apparently know 1,500 ways of using the bamboo plant. In Kenya bamboo is vital for soil stabilisation and construction. In Tanzania in the 1980s the government provided drinking water to 100,000 people through bamboo pipes, which proved to be four times cheaper than plastic pipes.

> 'Experience in several South East Asia nations show how, with innovative usage, bamboo has given shape to vibrant, sustainable local economics. India has the potential of emulating that feat, but it needs first to overcome the huge gap marked by research and its application, besides the red tape hurdle between the community and the forest bureaucracy.' [103, CSE]

In India bamboo forests occupy about 10 million hectares, roughly 13% of the total forest area of the country. The average yield is 10-15 tonnes per hectare. With an annual production of 3.23 million tonnes of bamboo per year, India is second only to China in global production.

Over-exploitation of bamboo

Bamboo is an undervalued resource often treated as free goods in India and because of this it is freely overexploited. The State Chief Conservator of Forests in Arunachal, K Nanchoom, told CSE: 'There is no complete inventory of bamboo. We have seen bamboo forests getting reduced in area as well as density'. He blames the unscientific collection by farmers, grazing (which destroys tender shoots), forest fires and clear felling by the forest department as the main causes of degradation.

Almost two thirds of bamboo annually cut in India goes into paper or rayon mills, and is sold to the industry at very low subsidised prices. 'Paper mills get bamboo at the ludicrous price of Rs1 per tonne (about 200 pieces of bamboo). Meanwhile craft societies registered with the Department of Industry paid Rs2.75 for a single piece of bamboo.' [103, CSE]

Maamen Chundamannil of the Kerala Forest Research Institute said at a workshop in 1998, 'In the last couple of decades bamboo, which was an abundant resource and was considered inexhaustible, has now become a scarce item'. In the mid-1980s, three paper mills in southern India, after having wiped clear local bamboo resources shifted their focus to the North East, especially Assam. Extensive tracts of Assam's bamboo forests were decimated. Today Arunachal, where a suicidal timber trade already flourishes, offers rich pickings.

Sustainable uses of bamboo

Unlike wood, bamboo grows quickly. It has to be extracted and utilised – left alone bamboo clumps die-off after flowering, which occurs in cycles varying between five to sixty years, depending on the species. Imposing stricter control and regularising extraction cycles can save bamboo forest. This would be one small part of developing a macro-economic policy for sustainable material use in India.

Vinoo Kaley, resident of Nagpur and an architect by training, became distressed that his education paid virtually no attention to the housing needs of millions of Indians. Unlike most of his fellow students who were eager to sell their skills to contractors in urban areas, he travelled the country learning about traditional housing methods and the various combinations of building materials used by common people – stone and mud, bamboo and thatch, wood and mud, and so on. Gradually bamboo became the primary focus for Vinoo's work. In the early 1980s he lobbied at different levels for dramatic policy changes towards what he saw as a valuable resource. Bamboo, he argued, 'could give us big dividends as an artisanal and house-building resource while paper could be made equally well out of sugarcane bagasse and other materials.

Even today there are about 20 lakh families of bamboo artisans in India, that is approximately 10 million people. Vinoo found that though their bamboo products played a crucial part in the rural agro-

industrial web, these groups did not enjoy any clout in society, because they 'belonged to communities which fall into the scheduled caste category'.

Alongside traditional bamboo craftsmen, Vinoo began to experiment with the design and production of many household items to see if bamboo could replace steel, wood, or plastic and other man-made materials. From bamboo they made dish-stands, soap stands, bookshelves, beds, tables and even a doorbell! A suitcase they designed made of bamboo featured in the popular Hindu film, 'Bombay'. Vinoo formed Aroop Nirman, an informal group of professionals working on bamboo related issues, which later tied up with The Centre of Science for Villages (CSV). Together they worked on the harvesting, preservation and construction applications of bamboo, giving special importance to designing methods for strengthening the joints in bamboo, with the use of natural fibres, resins, fibre-glass, wood and even steel. [27, Bakshi]

Today in Bihar bamboo is replacing steel in tubewell pipes because it is cheaper, rust-free and more durable. The Allahabad based Viklang Kendra, a rehabilitation centre for the handicapped, makes artificial limbs from bamboo. The strength, load bearing capacity and flexibility of bamboo make it virtually a 'regenerable steel', and therefore an excellent engineering material. Its fibers have potential to replace glass fibers. Many plastic products could be effectively replaced by bamboo – piping, waterproof concrete shuttering, plastic tarpaulins – and not the other way round, which is currently the case.

Conservation through empowerment

By promoting plastic over wood and bamboo, the Government of India is unequivocally promoting the process of urbanisation, machines over man, and simultaneously dis-empowering and breaking up village society. A planning process that sees plastics as 'eco-friendly' because 'plastics substitute wood in a number of applications and so help forest cover, which is essential for maintaining ecological balance' is blind to the necessity of regenerating rural bio-based industries to provide material needs.

Substituting plastic for wood or bamboo does not preserve forest or bamboo cover, but destroys it by ignoring its potential. What is

needed is a comprehensive Indian (not ex-colonial) forestry and materials policy which protects forest cover by giving it back to the people that live and work in it. For this to happen, government must devolve responsibility to the caretakers of the forests, the people that live there. And they must reform land rights with rural communities. Reforms that centrist politicians and rural landowners resist.

Attempts at Land Reform in India

The Indian National Congress made land reform a priority in order to encourage the peasantry to join the struggle for independence. 'The communist governments of West Bengal and Kerala have pushed through relatively complete land reforms. In other states like Karnataka and Maharashtra it has been the pressure from the left that has been instrumental in persuading Congress governments to implement land reforms.'

But on the whole this promise has been left substantially unfilled. 'Elsewhere, notably in the fertile agricultural tracts of the Gangetic plains and the fertile northern states of Punjab and Haryana, along with parts of the Godavari, Krishna and Kaveri deltas, a new class of large and medium sized landowners have grown rich on the increased productivity from the chemical inputs of the 'Green Revolution'. This has left masses of impoverished rural peoples. In the absence of land reform, they have had no recourse other than to encroach upon common lands, leading to further denudation of bio-resources and social conflict. Others have become migrant landless labourers, exploited and working for pitiful wages. Many more have flocked to the cities to find employment. They swell the numbers in urban shanties and are vulnerable to clearance projects as urban land prices rocket and developers can sell their meagre spaces for higher-income housing or offices.' [26, Gadgil and Guha]

7 Plastics threat to traditional materials

Both foreign earnings and substantial employment 'can be achieved by integrating the petrochemical industry to the handicrafts/cottage industry wherein petrochemical inputs like plastics and synthetic fibres are used as raw material for producing articles of ethnic nature, which have a ready international market. ...Natural resources like cane, straw, wood etc can be replaced by plastics and other synthetic materials to make products like hand-woven baskets, toys, carpets etc'.

Government of India, Rakesh Mohan Experts Group Report on Petrochemicals, 1993

Professor Barry Commoner argued in the 1970s that for the petrochemical industry to succeed against labour-intensive industries such as wood, wool or leather, it required pushing volumes to the limit and finding a use for every by-product. 'By its own internal logic,' he maintained, 'each new petrochemical process generates a powerful tendency to proliferate further products and displace existing ones'. The petrochemical industry obeys a ruthless marketing logic, whereby to pay back investment and reap profit, it has to replace many natural materials with petrochemical products. The key economic factor challenging traditional crafts and cottage industries or large-scale traditional industries such as the jute industry, is the fact that a plastic product can be mass-produced ad infinitum.

Table 12 Some conventional materials replaced by polymers

Sector	Polymers Used	Conventional materials replaced
Packaging		
Milk	LDPE film pouches	coated paper, metal, glass
Beverages	PET	glass
Beverage crates	HDPE, PP, PPCP	wood
Pharmaceuticals	PVC, HDPE, PP	glass, paper
Squeeze tubes	HDPE, LLDPE, PP	metal
Soaps	LLDPE, LDPE, PVC	shrink wrap paper
Retail carrier bags	LADE, HDPE, HM	paper, jute bags
Pallet wrap	LDPE, LLDEP	heavy duty paper
Fertiliser	HDPE/PP woven sacks	jute
Cement	HDPE/PP woven sacks	jute
Mineral	LDPE heavy duty	jute
Storage tanks		
Water	LLDEP (rotomolded)	cement, mild steel
Septic tanks	LLDPE, HDPE	cement
Agrochemicals	HDPE,	steel
Automotive fuel	HDPE, PP	steel
Textiles		
Textile apparels	PP, PET, Nylon, Acrylic	cotton, rayon, and silk
Strappings	PP, HDPE	coir, jute, steel
Ropes	PP, Nylon	coir, sisal, jute, steel
Cushioning material	EPS, PU, PP, PE	flannelcloth, paper
Upholstery fabrics	PP, PVC rexene	cotton, rayon, jute
Carpets	PP, Nylon, Acrylic	coir, jute
Furniture	PP, PPCP	wood, cane, bamboo
Toys	PP, AVS, HIPS	wood, sheet, metal
Luggage	PP (impact), ABS, FRP, PPCP	wood, steel
Textile cones/bobbins	PP, FRP	cardboard.
Shoe soles	PVC, PP, foam, PU	leather, rubber
Construction		
Pipes/tubings	PVC, HDPE, LDPE	cement, steel
Windowpanes	Polycarbonate, Acrylic	glass
Buckets, tumblers	HDPE, LLDPE, PP	sheet metal, brass
Window and doorframes	PVC, FRP	wood, steel, aluminium
Sign boards	FRP, Acrylic, LD foam	wood, metal
Appliance housings	ABS, FRP, PP, PPCP,	structural foam metal
Plumbing fixtures	Polyacetals, ABS, PP	stainless steel, brass

Sources: Economic Times 19 October 1993

Therefore, once established in the market, plastic products will always beat traditional materials on price.

By price, persistence and sheer volume, plastics are effectively taking over Indian traditional markets. (Table 12 lists the main take-over products) But at what cost? It is the death of an economy of permanence, artisanal industries, generational traditions, social networks. Niche markets – all that will remain – are a sop; people will no longer live by jute or kulhad, but only decorate their lives with it.

There are no accurate statistics on the numbers of people or products being replaced by plastics. The lack of data and an overall policy on the artisan sector shows the government's total apathy to this sector. The Centre for Science and Environment points out that neither the National Income Accounts published annually by the Central Statistical Organisation, nor state level data make any mention of the artisan's contribution to the GNP. [97, CSE]

It is not surprising that statistics are not available. The majority of people living outside urban areas of India continue to subsist on traditional crafts and services, which remain invisible to market orientated development.

The Jute Industry

In the absence of comprehensive data, it has been difficult to estimate the full impact that the expansion of commodity plastic production is having on employment, economics or culture in India. However the one major Indian industry where data is available and where the impact of plastics on livelihoods can be best illustrated is on the jute industry of (mostly) Bengal.

Once jute was the highest earner of foreign exchange for India (for several decades, until the late 1970s), accounting for as much as 30% of the total export earnings. Today jute goods account for a little over 1% of India's total exports. However, it still fetches over Rs620 crores (US$155 million) worth of foreign exchange. Now 90% of production is for internal consumption compared to less than 25% earlier. [104, Singhvi] India is still the world's largest producer of jute fibre, and it is also the world leader in jute goods. Jute ranks second only to cotton in terms of total world natural fibre production with

over 3 million tonnes of raw jute grown annually, principally in China, Thailand, Bangladesh and India.

The market for jute is effectively being eroded by the polypropylene industry and particularly for sacking, the Indian jute industries largest market.

Environmentally beneficial

'Eco-friendly' has recently become an important marketing tool for jute. Sri G.M.Singhivi, Chairman of the India Jute Mills Association and the Indian Jute Industries Research Association, sets the tone:

> 'In the present context there is an ever increasing awareness of the ecological and environmental concerns and it is believed by informed circles that there may be a great revival of interests in the use of this natural fibre packaging material. Plastic bags being non-biodegradable are considered a great potential threat to mankind.' [104, Singhvi]

Jute is generally considered an ecologically sound material because of the following factors:

- Jute is a renewable fibre.
- Jute has a short growing period and is rotated with food crops. This improves soil fertility and reduces incidences of weeds and plant disease.
- Jute is cultivated without irrigation and few pesticides are used.

Table 13 is a MET (Material Energy Toxicity) matrix picture of the jute life cycle. This matrix is not quantitative – and it is therefore only indicative. The astrix marks denote areas are the main negative environmental aspects of jute, predominantly pesticide use. Although fundamentally a sound sustainable material, it is still necessary to improve jute's environmental impact to comply with environmental standards in export markets to acquire 'Eco-labels'. In particular:

- Minimise the applied amounts of pesticides.
- Retting the decorticated plant instead of the whole plant.
- Soften jute with vegetable oils instead of mineral oils.
- Eliminate the sizing process by spinning stronger, smoother yarns.
- Improve dyeing systems.

Table 14 Material Energy Toxicity (MET) matrix of jute fabric

MET Matrix	Material Cycle	Energy Use	Toxic emissions
Production and supply of materials	Input: - fertilisers - pesticides - water consumption, retting Uptake - CO2 Output - organic waste	Input - **Production energy fertilisers and pesticides - **Transport Output - energy (incineration jute sticks)	To water: - **fertilisers - **pesticides - BOD and COD during retting
In house production	Input - **mineral batching oil - bleachin/dyeing chemicals - auxiliaries - water consumption, bleaching/dyeing	Input: - process energy, spinning, weaving, dyeing - transport Output - energy (incineration jute waste	To water: - **bleaching/dyeing chemicals and auxiliaries to the effluent
Use	- short life time		
Disposal		Output: - energy recovering (incineration of jute)	

** denotes the main causes of negative environmental impact of a jute fabric

Source: [105, Hendriks]

Some of this work is being done. For example, the recent UNDP/GOI programme has improved retting systems. Rice Bran Oil (RBO) has been developed to replace mineral oil.

Jute's Eco-Friendly life cycle

Jute is commonly rotated with food crops such as rice and potatoes, which has a number of advantages: it generates increased agricultural production, maintains and improves soil fertility and reduces the incidence of weeds and plant diseases.

After the jute plants have been cut, they are kept in heaps for about 3-4 days of defoliation. Most of the leaves are left on the land and serve as organic fertiliser. Bundles of plants are transported to nearby 'retting' facilities. 'Retting' is the process of fibre extraction and involves steeping the stalks of the plant (up to 4 metres long) in ponds or slow moving streams. Bacteria present in the water attack the tissue surround of the fibre. Retting can take 5 to 22 days depending on several factors like water temperature, acidity etc. Retting in flowing, instead of stagnant, water improves the fibre quality.

After retting, the fibre is stripped from the residue of the stem. The by-product, jute sticks, serve as fuel for the farmers or as composite material in floor or wall panels. Increasingly the sticks are being used in the manufacture of paper.

The fibre is then graded according to quality. This depends on a number of factors: on the variety of the original plant (tossa jute or white jute); the climatic conditions during growth (both tossa and white jute like a hot, moist climate) the retting process); the cleanliness and the availability of water nearby the cultivated plants and the retting time.

After grading, brokers sell the jute to purchasers from jute mills. Jute bales are transported to the mills where they are softened with a batching emulsion of mineral oil, water and emulsifier. After the oil thoroughly penetrates, the roots are cut off to produce low quality rope. The jute is then 'carded' and 'drawn' to paralyse and straighten the fibres and remove impurities. From then onwards the fibre is conventionally spun and woven, bleached and dyed into a variety of products. [105, Hendriks]

Employment in Jute

There are various quoted figures of the number of people directly or indirectly employed by or benefiting from the jute industry. The jute industry employs directly 250,000 industrial workers, 500,000 in the secondary and tertiary sector and provides livelihood for 4 million farmers and their families. [105, Hendriks] [106, Venkatesan] One estimate states that a total of 30 million people depend on jute agriculture and industry directly or indirectly, wholly or partly, for their livelihood. [104, Singhvi] All analysts agree that the jute industry is one of the most highly labour intensive industries in India. The employment cost is presently over 35% of the total cost. (The raw material cost fluctuates between 35% and 50%.)

Jute markets

By far the most important and largest sector for jute products is bags, sacks and hessian, accounting for between 70% and 90% of all production. Jute sacks are mainly used for cement, urea, and foodstuffs, including rice, sugar, flour, grain, pulses etc.

Lesser markets are carpet backing, coarse yarn and twine. Nowadays, as we shall see, the industry is attempting to diversify into other areas such as furnishings, carpets and fabrics, as well as non-textile applications like handicrafts, brake linings and moulded products. However, as yet, these products only use between 3% and 8% of the total jute production of India.

Diversified jute products include: carpets and other types of floor coverings, jute furnishing fabrics, special quality hessian cloth, high quality jute yarn, blended jute yarn and fabrics, wool and jute blends to manufacture blankets, felt, webbing, scrim cloth, and hydrocarbon-free bags. Other diversified jute products use jute stick, jute waste, and jute non-woven hessian, for example, jute handicrafts, jute composites, particleboard, brake linings, moulded products e.g. window and doorframes, laminated sheets, and geo-textiles.

Decline of the jute barons

The story of the jute industry in India is the story of some of India's great trading families. The heyday of the jute industry was in the 1950s to 70s. Many of India's chief family trading conglomerates such as the Kanorias, Goenkas and Bajorias had jute mills as centrepieces

of their financial success. These mill owners, through their numerous matrixes of relatives, often controlled the procurement of raw jute. They bought from the farmers at very low price. They hoarded raw stock, then sold it to their own mills at a substantial premium. Though the mills suffered because of a high raw material price, the mill owners themselves made a personal fortune, selling the raw jute through traders. 'That the mills were affected did not matter as they could always shed tears before the government and get assistance.' [107, Business India]

Through front men, the owners began to control the export business as well as the buyers. The buyer's cartel would force the mills to sell at highly subsidised rates while they would make a killing on the deals. The mill's finances were thus pressurised from both ends, while the owners made money from every deal. The entire business was on a cash basis – government saw little tax – and most mill owners became extremely wealthy. Hardly surprisingly, this system was unsustainable. Having milked the mills dry, owners looked to other businesses to finance, and ironically some are now heading the cement or petrochemical industries, helping to put the nail in the coffin of their previous enterprises. The Birla Group, for example, have sold all but one of their mills and it is thought they will be out of jute within two years. [108, Kajaria] The last of the jute barons, Arun Bajoria, is on the run, trying to evade the dreaded Enforcement Directorate for allegedly siphoning Rs4 crore out of the country in a hawala (illegal currency exchange) transaction.

Decline in consumption of Indian jute has been 25% in the last 25 years. [109, van Riet] This is in line with world consumption, and has been attributed to a number of factors:

- The decline of the former USSR as a customer for jute goods following its break-up and subsequent shift towards market economies.
- The introduction of bulk handling techniques, for example containerisation for grains and foodstuffs, which have adversely affected the jute sack market.
- The market that was left has been challenged since the mid-1960s onwards by the new polymer material, polypropylene (PP). [110, Montgomery]

The rise of polypropylene

Polypropylene (PP) sacking was an invention of Patchogue Plymouth, a cordage company in the US who hit on the idea of slitting PP film into narrow strips then stretching them to develop strength before winding into a sort of synthetic raffia. This tape, or 'film fibre' as it became known, was more textile than plastic to handle and was eminently suitable for weaving. Other sackings for corrosive fertilisers, for example, use HDPE and LDPE.

Few predicted then that polypropylene resin would, in 30 years, become cheap enough to push jute out of its main markets. Resin quality improved with better catalysts and soon polymer prices were reflecting these gains. Capacity grew and prices dropped – from US$5,000 per tonne in 1966 to US$1,000 tonne in 1970 – reflecting the lowering cost of propylene inputs and the inexpensive cost to convert this abundant raw material to resin. There were other factors that improved PP's chances on the market:

- Improved ultra-violet stabilisers used in PP polymers.
- New generation polymerisation catalysts producing higher yields at lower costs.
- Development and use of narrow molecular weight PP resin.
- Rapid installation of PP polymerisation and textile processing capacity in many countries around the world.
- The highly mechanised 'Film Fibre' process of converting resin to finished fabric compared to labour intensive jute goods manufacturing.
- Aggressive marketing by resin producers to promote use of PP resins in both moulded and textile products.
- Polymer plants supplying the versatile PP and HDPE/LDPE resin for mouldings as well as textiles were springing up throughout the world's petrochemical industries.

By 1996 the writing was on the wall for jute. Jute was forced to meet the challenge by accepting ever-lower prices (in constant dollar terms) for its products. Raw fibre, which fetched US$400 per tonne in 1970 in current (much-depreciated) dollars, now fetches about US$300 per tonne. Today, world-wide, for every jute bag there are 5 or 6 polypropylene bags being made and sold. [111, Mackie]

Weaknesses of the jute industry

• Farmers in India predominantly grow inferior quality jute. The best raw jute qualities like Tossa jute TD1-2 and White jute W1-2 are mainly available in Bangladesh. This limits the quantity of jute available to spin fine regular yarns for higher value textile products rather than sacking and hessian.

• Retting in India often takes place in stagnant water. Ecologically this can lead to excessive generation of biological oxygen demand (BOD) and it also reduces the quality of the raw jute.

• The grading system favours quantity over quality. The inferior Tossa jute gives better yields.

• Farmers commonly harvest after 120 days, when bulk is maximised but quality is reduced.

• A large number of middlemen are involved in the transport and sale of raw jute from farmers to manufacturers. 'They tend to appropriate a disproportionately large financial margin as compared to the services they render.' [105, Hendriks]

• 'Jute farmers are resource-poor, socio-economically weak, unorganised and they do not have holding capacity. These circumstances oblige them to dispose of the bulk of their raw jute immediately after the harvest at un-remunerative prices in primary markets or in the village itself.' The weighing of jute is sometimes manipulated to the disadvantage of the farmers, who are often obliged to accept and suffer deductions on various counts. [106, Venkatesan]

• The machinery in mills is mostly outdated, poorly maintained and unable to manufacture higher value textiles. The processing technology for the preparation of jute fibre for spinning has not changed appreciably in 50 years. [110, Montgomery]

• Raw material and labour costs are high - accounting for over 80% of the total cost of production of jute goods. The industry has no control over either price. In the case of raw jute the industry is bound to pay the statutory minimum price and even higher prices in years of scarcity. Labour costs, fuelled by the rising annual payment, have also been rising, as wages are determined every quarter by an established formula linked to the CPI through a system of dearness allowances. This has been spiralling every quarter.

Jute versus polymer

India was slow to react to the polymer threat to jute. In part this was due to the security of the huge internal market for jute sacks for packing food staples, cement and urea. In the siege economy of the first four decades since Independence, high custom tariffs protected jute from imports of polymer resin and until the mid-80's domestic production of polymers was small.

The jute industry did not help itself – it neither modernised nor developed alternative products. Indeed, from growing raw jute through to manufacture and marketing, the industry in India is notable for poor practices and inefficiencies.

Few Indian jute companies have fully understood how to develop effective marketing strategies that will succeed in northern countries. Marketing is often confused with promotion and it is done by outside marketing intermediaries with little understanding of how to meet customer requirements. National marketing strategy is usually based on generating bulk quantity of traditional products (sacking and hessian) for the lowest price. However some mills, for example, Champdany, Birla, Ludlow, Cheviot and Naihaiti have diversified into shopping bags and fine fabrics, and are exporting with some success. These are among the few profit making mills. [105, Hendriks] Others, notably the largest mill, New Central Jute Mills (NCJM), owned jointly by the workers and the Government of West Bengal, is operating from one financial crisis to the next.

Today's sick jute industry

Of the 60 jute mills operational in India, 50% are considered financially 'sick'. During the year 1993-4 (the most recent year for reliable statistics), the number of profit making units fell from 37 to 29 and loss makers increased from 16 to 24 compared to the previous year. [106, Venkatesan] The top five loss makers are all in the public sector. The Table 14 makes the position clear.

Table 15 describes the financial situation of NCJM (New Central Jute Mills). The figures show that an increase in turnover caused an increase in losses. NCJM are stuck in a negative spiral – there is no capital available for investment and product innovations, there is no capital to buy raw jute stock when the price is low. They must continue producing products to be sold at a loss.

Table 14 Profitability of mills vis-à-vis industry average, 1993-4

	Number of mills net profit margin basis	Number of mills return to risk capital basis
Above average	4	15
Below average	25	7
Negative	26	33

Source: Jute Commissioners Office National Council for Applied Economic Research, December 1996

Table 15 Profit, loss and turnover of New Century Jute Mills

	Profit and Loss NCJM million US$	Turnover NCJM million US$
1986	-0.7	8
1987	-0.7	2
1988	-0.2	12
1989	-0.7	15
1990	-2	17
1991	-1	21
1992	+1	25
1993	-1	22
1994	-3	24
1995	-4	25

Source: Hendriks, 1997

One major disincentive that operates throughout the Indian jute industry is that wages of jute workers are not linked to productivity. This is in sharp contrast to the textile industry which pays a higher wage than the jute industry, the higher wage being more than compensated by higher productivity. [106, Venkatesan]

The potentially lucrative export market for jute is not materialising. Retailers in the north mostly maintain low inventories, and therefore expect orders to be regularly met. Indian jute companies are often so short of cash that jute is bought only when an order is confirmed, often not at the best market price, leading to irregular or late deliveries. Export markets in the north demand quality and guaranteed delivery. Increasingly, institutional eco-criteria are required for 'value-added' products. Neither can be delivered by the often over-stretched Indian jute industry.

Government protection

Government response to the crisis in the jute industry has been twofold. First taxes and other funds have been made available and bodies created to administer them. Minimum Support Prices (MSP)

for different varieties and grades of jute were installed in 1966-7 and the Jute Corporation of India was set up in 1971 to protect growers' interests. Second, national legislation has been enacted to protect the core domestic markets of packaging foodstuffs and commodities. A low 1% tax was levied on all jute products. If a product contained more than 50% jute, no taxes were to be paid. In this way the GOI hoped to stimulate the export of jute products, which could, after all, be a valuable source of foreign exchange. At the same time government restricted the import of raw jute from Bangladesh to protect its own industry.

In the face of threats from poor harvests and a collapse in prices in the mid-1980s, the GOI created the Jute Modernisation Fund and the Special Jute Development Fund. In the early 1990s the GOI, working with the United Nations Development Programme (UNDP), established the National Jute Development Programme to promote jute product diversification 'for the rejuvenation of the sector as a whole'. [112, Prasad].

The government continues to provide financial support for loss making jute mills and acts as an intermediary between banks and mills to prevent closure. The GOI has also determined three stages of 'closure' to protect, as far as possible, the jobs of full-time employees.

NJDP Programme

The National Jute Development Programme was initiated in 1992 with US$20 million from UNDP and a matched amount from the GOI. The range of projects was wide, including the development of new products and indigenous machinery manufacturing capability, and directly benefitting women and weaker sections of the community like jute growers, handloom weavers and small entrepreneurs. Special emphasis was placed on improving retting processes by means of building demonstration community retting tanks. Under this programme there were 26 projects related to applied research and development. By the end of September 1997 US$17.8 million had been utilised from UNDP sources. The UNDP programme ran until 1998.

Critics of this project say the programme has been too unfocused, involving bureaucrats but not market leaders. Too much effort has been placed on uneconomic units and the successful, market-led mills are not given support. It would have been preferable to see the industry downsize, leaving the playing field open to those that can survive. [108, Kajaria]

Jute Packaging Materials Act, 1987

The most contentious measure enacted by the GOI was the Jute Packaging Materials (Compulsory Use in Packaging Commodities) Act of 1987. This made it compulsory for all sugar and food-grains and 50% of urea and cement to be packaged in jute sacks giving the jute industry a huge captive market for its core products and shut out expanding polymer production. Opposition to this act has come openly not only from polymer producers but also from the cement industry, now supported by the Industry Ministry. [113, The Pioneer] They argue that not only are jute sacks more expensive, but they lead to massive leakage and wastage of the product they encase. The jute industry hotly disputes these assertions, arguing a certain amount (1.2%) of spillage and seepage is acceptable, bearing in mind the other advantages of jute over plastic – the free movement of air, durability and recyclability. The advantages of jute over plastic were ironically described by the Plastic Woven Sacks Manufacturers Association: 'The better handling and stacking characteristics of jute bags, their easy reparability, the fact that they can be printed upon by aqueous or oil based inks and that there is negligible seepage loss when food-grains are packed in jute goods.' [106, Venkatesan]

In practice the cement industry has ignored the Act and most cement is now packaged in plastic. The jute industry went to the courts. While upholding the validity of the 1987 Act, the Supreme Court in 1996 suggested that the Standing Advisory Committee of the Ministry of Textiles should take into account the views of users before recommending the extent of use of jute bags. Jute manufacturers, under the banner of the Indian Jute Mills Association then filed a petition in the Delhi High Court against the continuous violations of the 1987 Act. Immediately thereafter the Jute Commissioner issued notices to all cement manufacturers threatening penalties for not using jute bags for packing cement.

There seems little political will, however, to enforce the legislation. Not only the Industry Ministry, but also a major financial institution, the Development Bank of India (DBI), has urged that the cement industry be exempted from the 1987 Act. [113, The Pioneer] It is interesting to note here that the DBI is one of the key sponsors of Reliance's Jamnagar project which will bring a further 400,000 tonnes of polypropylene (PP) into the Indian market.

Jute Industry fights back

'The cement industry says that jute bags are inefficient and unsuitable for cement packaging, that there is spillage and seepage of as much as an additional 4%. There are certain minimum packaging norms fixed for the cement industry, which allows only a certain amount of seepage, in respect of all kinds of woven bags, be they plastic or jute. ISI standards were formulated and it has been found that the jute bags meet all the required standards limiting the seepage to no more than 1.2% despite hooking. In the case of plastic woven bags, the seepage as claimed by the cement industry is only 0.8%. However if any metal hooks are used the seepage will multiply to an unlimited extent. If we were to take into account the bursting losses of plastic bags, the actual loss in packaging would be higher than in case of jute bags.

'These are findings of a detailed study made by no less a body than the apex research institution body for the cement industry namely the National Council of Building Materials. Of course, there is a rider and that is the jute bag must conform to ISI specifications. In other words the cement manufacturers must buy a proper standard jute bag conforming to ISI specifications. Of course plastic bags are cheaper. As a first buyer a cement manufacturer will have to pay substantially more to use jute bags but jute bags are always reused repeatedly for one purpose or another and in the long term it works out to be cheapest.' [104, Singhvi]

A report commissioned by The Plastic Woven Sacks Manufacturers Association and the All India Flat Tape Manufacturers Association recommends that urea should also be packaged in synthetic bags. It also notes that, 'though the prevailing practice of packaging sugar is in jute bags, the sugar industry seems to prefer synthetic bags'. [106, Venkatesan] For domestic consumption this would only leave foodstuffs such as rice and wheat as a suitable market for jute. The report notes, 'foreign importers specify rice to be packed in PP bags'. Other analysts confirm this bleak picture for the core market of jute sacking. Sanjay Kajaria, Director of the profitable Hastings Jute Mill, agrees that sugar will follow cement into synthetic packaging.

Future of jute in niche markets

At the Jute India 97 Conference in New Delhi, the Secretary to the Minister of Textiles, Mr Prabhat Kumar, announced that within two years all subsidies to the jute industry would stop.

Gordon Mackie from Northern Ireland has manufactured machinery for the jute industry for 30 years. Nowadays he is an international textile consultant, with an overview of both the natural and synthetic fibre industries. He has witnessed the decline of the industry and predicts that only niche and core markets will remain:

> 'Jute usage will continue to decline during the 1990s at around the same rate it has during the 1970s and 1980s. After the year 2000 the drop in consumption should slow as jute retains its final niche or core markets, those where it has a genuine competitive advantage occasioned by its own intrinsic quality and merits. These advantages may be, for example bio-degradability, better protection of valuable seeds or food grains in transit, re-usability, lower foreign exchange costs for the country of origin and use, etc.
>
> The superior bio-degradability of jute does assist its potential in a few narrow market niches – soil saving and soil stabilising, geo-textiles and horticultural wrapping fabrics, for example. However, these are *minor markets* using perhaps 20,000 tonnes out of a total jute manufacturing capability in India, Bangladesh, China and elsewhere of 2.5 to 3 million tonnes per year.' [114, Mackie]

Sanjay Kajaria of Hastings Jute Mill is not heartened by jute diversification: 'These same jute shopping bags were around 30 years ago. At present diversification consumes only 3% of jute produced, and at best fine yarns will account for only 10% of the total.'

Mr Ajay Prasad, National Programme Manager of the United Nations Jute Development programme, is more optimistic. The years 1996-8 saw bumper crops. Prices for raw jute were the highest ever in 1996 and the long-term trend is upwards. 'Every approach is being tried to find new markets for jute. For example, replacing wood and plastics in buildings, automobiles and paper manufacture; mixing jute with PP to make laminate furniture such as shop and bar counters.

There is enormous potential for composite materials.' He demonstrated with a section of a jute composite doorframe. 'Jute could replace asbestos in car brake linings. India was now exporting jute brake-linings to East Africa.' He is confident that 'value-added' products will increase consumption of raw jute from 8 to 25% of total jute produced. [112, Prasad] Indeed the export of polypropylene-lined jute bags was one of the bright spots in lowered export figures of plastic products in 1997-8 – a considerable irony. 'The exports of these bags was up by 122.9 % to a value of US$2.92 million.' [115, Financial Express]

When GOI subsidies end and the full PP capacity of Reliance and IPCL of 940,000 tonnes annually comes on-stream by the year 2000, however materially efficient or ecologically beneficial jute is, one could predict the almost complete loss of the sacking market, a substantially downsized jute industry, with consequent huge job losses. Mr Prasad is a servant of the GOI. In response to a question about continued government support for the beleaguered jute industry he replied with a well-fed smile, 'How long can you support a product which no-one wants?'

Disappearing traditions

The collapse of village economies and the resultant pressure on overburdened urban infrastructures is a key socio-economic and environmental problem in India, as in the south generally. The extruding machines of plastics are eroding the traditional craft-based industries, passed generation through generation, and throughout India. These skills will disappear; peoples' livelihoods will end as they forsake their village community for the cities. The examples outlined below describe a few products and how threats to their continued production (not only attributed to plastics) have affected crafts persons and their families. In the absence of any comprehensive data, these are a series of 'snapshots' of disappearing cultures.

A quintessential Indian utensil fast disappearing is the kulhad, the mud cup, which is still used as a chai (tea) cup in trains. The earth kulhad has been fired, and is used only once – guarding against contagious disease, and necessitating employment for the manufacture of more kulhuds. After use it is thrown to the ground – mud to mud. The faster Shatabdi express trains charge a premium to attract the middle classes on journeys between Indian metropolises. Instead

of the chai-wallah with kulhads and the pakora vendor with leaf plates, food is served modern airline-style on plastic trays, in plastic cups. Food is wrapped in plastic and tea, coffee and milk comes in packets – symbols of middle-class India embracing a northern culture. Going and gone are the chai-wallah, and the families who made the kulhads. Seemingly here to stay is non-biodegradable plastic waste, thrown out of the train window to collect in the landscape, fill landfills or accumulate in the street to create havoc with the stomach of the ever-present cow.

Some products have already disappeared completely, for example, the traditional zinc *badle* of Rajasthan, used for transporting water. Other traditional consumer durables, furniture and household goods are also under threat from plastics.

Badles (water bottles)

The traditional zinc water bottles with felt insulation were crafted in the Jodhpur region of Rajasthan. Manufacturer Radheyshyam Kansara opened a cupboard piled high with unsold bottles. 'Although we could make badles to order in a number of styles, (some with compartments to hold ice), we could never compete with mass produced plastics. Some 400 local people used to get their living from this trade.' His business collapsed 7 years ago and now the same badle craftsmen stamp out aluminium icons of Shiva for the tourist trade. [119, Kansara]

Pottery

Ram Swaroop, 57, from Jaipur, is a kumhar, a caste that works with clay. He practices his family tradition of pottery in Khirki Gaon in New Delhi. Swaroop still feels that traditional crafts are more rewarding for the poor people than factory jobs. A craft gives occupation to the whole family – women can help and young sons can do the running around until they master the craft. A factory job, on the other hand, employs just one person and the small amount of money earned is not capable of keeping the family together. [117, Swaroop]

Vijay Kumar, 35, a kumhar from Chinhat in Lucknow, has been practising pottery for the last 20 years. He finds it increasingly difficult to sell his goods in his native place and looks forward to exhibitions around the country to sell his craft. 'Plastics have come into our rural environment so where can we sell if there is no one to buy?' At exhibitions his pottery fetches higher prices since buying handicrafts

has lately acquired an elitist market in the country. Wearing or using hand-made things has become more of a statement than the natural choice it used to be. [118, Kumar]

A *surahi* is an earthen pot made for storing water, with a tap opening at one end. About 10 years ago it used to cost Rs5 and could efficiently serve the needs of five people on a 24 hour train journey. The pores of mud kept the water cool in hot Indian summers. Nowadays you only find surahi in exhibitions. It's replacement, a plastic-mineral water bottle costing Rs10, is inadequate for a single person on a long journey. In terms of cost, convenience and efficiency the surahi makes more sense – it is Rs5 against a Rs100 (Rs20 per person for 24 hours) and water does not stay cool in plastic. The surahi can be thrown away at the end of journey – earth to earth – or taken home and used for years. It's a different story with the plastic bottle: at the end of the journey most people leave them and they are often filled with tap water and re-sold. Discarded or broken plastic bottles litter the landscape: because of the low plastic quality they are often ignored by ragpickers.

Furniture

Moodha, an easy chair with a round firm base and armrests, is the speciality of Gadhmukteshwar, a small town in Uttar Pradesh (UP), about 150 kms from Delhi. A moodha is made from a plant called moonj with a straw-like stem with leaves and fibrous roots. The craftsmen use the shoot to give shape and strength to the structure. The lower leaves and the fibres from the root are beaten to get a fine jute-like thread, which is used to tie the whole structure. The finished product is light and can be easily carried around the house. The moodha is now being replaced by colourful PVC plastic moulded chairs in cafes, small restaurants and on private balconies.

Bhupinder now travels in the northern parts of the country to sell his moodhas. He sadly recalls that once, in the time of his father, there was a lot of respect for the craft. 'People returning from holidays in the UP hills usually took back moodhas for their urban homes. On weekends some families used to come from Delhi just to buy our moodha.'

Bamboo chiks and chatties

India's 8.2 lakh cane, bamboo and fibre workers (1981 census) are the country's third largest group of artisans. Most of the traditional bamboo workers making chiks (blinds) are today leading a hand-to-mouth existence. Chiks were commonly used to shade balconies from the wrath of the Indian summer before plastic venetian blinds arrived in the market. As a chik made of bamboo is porous, air can easily pass, and by sprinkling it with water it becomes an effective cooler. The modern plastic blinds wear out easily, become brittle in sunlight, last one or two seasons, and cannot be effectively watered.

'Even chatties (mats) made out of bamboo, coir and grass are slowly giving way to plastic made mats,' says Jaya Jaitley. [120, Jaitley] The chattie used to be the most popular choice for floor sitting. It is light, can be easily folded and washed without causing any damage. Dust-bins, penholders, ashtrays, chopping boards, curtains – hundreds of household things traditionally made from bamboo are now being replaced by plastic.

The leather industry

In the footwear market, plastic or rubber footwear is replacing hand-made leather juttis and slippers. Kamal Nanavaty, vice-president of Reliance Industries, offers a pair of PVC chappals at an affordable price for those who once went barefoot. Synthetic soles are fast replacing hard vegetable tanned buffalo leather.

Accurate data on leather workers is not available, but according to the 1993-94 annual report of the Khadi and Village Industries Commission (KVIC) 'There are about 15 lakh (1.5 million) artisans engaged in the leather sector in India. This consists of the urban/organised sector engaging about 1 lakh and the rural/unorganised sector engaging about 14 lakh artisans.' (These figures are the sum total of craftsmen engaged in tanning and flaying.)

Some efforts were made by the government to rejuvenate the village leather industry. A UNDP (United Nation Development Project) funded project, in collaboration with the footwear Design and Development Institute of Noida (UP), was launched in 1995 to train the traditional leather workers of Jaipur in 'modern' (European) designs on imported Italian machines.

LEATHER WORKERS

The chamars (a caste that works with leather), had their own shops to display their leather shoes. Rama Leather Works is one such shop in Mandi, Himachal Pradesh (HP), which had a flourishing business a few years back. Office shoes, formal shoes for weddings and leather sandals were all made in Rama's shop. Rama's sales for finished shoes have declined sharply in the past few years and most of the time, as cobblers, they do repair jobs on factory-made shoes.

Sewak Ram, 49, an emigrant cobbler from Chamba in HP, came to Delhi at 30 at the insistence of his first cousin, who has a three-room jhuggi (mud house) in the slums of Krishan Nagar in Delhi. He is a chamar by caste and used to work for a footwear unit. Chamba was nationally known for its leather footwear. Now the industry of Chamba chappals is slowly dying, as it is becoming increasingly difficult to compete with cheap plastic alternatives. Ram is not teaching either of his two sons the craft: 'The younger generation is not interested in traditional footwear any longer, they want factory made shoes.' [121, Ram]

Niche markets remain

What is left for the traditional material products is the small niche markets – less than 10% of the present jute market, probably more like 5% for the traditional craft industries. In these niche markets the material has a genuine competitive advantage occasioned by its intrinsic quality and merits. These will be value-added products – smaller in volume, larger in price, and many will be for tourists, usually foreign, seeking traditional crafts to take home as presents or memorabilia. The foreign tourist has no doubt had their fill of plastic from back home.

Most efforts both by government and non-government agencies to promote traditional materials have focused on upgrading their technology. Little attention has been paid to the problems of raw material and shrinking markets. Some of the improvements introduced by the KVIC have been the ball-bearing potter's wheel, the Sheila electric potters' wheel, and improved brick-kilns for potters and earthen pipes for irrigation and drainage, janata sheetaks (water coolers), water filters, and magan chullahs (smokeless stoves).

More successfully, have been the enterprises that promote the grass roots market, rather than stand alone technology, such as Delhi Haat. 'I had to create a place like Delhi Haat in order to sustain the handicrafts of the country,' says Jaya Jaitley, crafts consultant and head of the Dastkari Haat Samiti in Delhi, developed about ten years ago. [120, Jaitley] Haat is an ancient Indian marketing system, where nobody owns the place but crafts people come in regularly to sell their products. For artisans who have limited quantities of merchandise to sell and lack access to other markets, the Haat is a valuable marketing outlet. [122, Srinivisan] Over 600 craftsmen regularly come to this complex in Delhi to sell their goods.

Wooden toys to Delhi Haat

Arshad, 36, from Saharanpur, comes with his wooden articles and toys to Delhi Haat. Sheesham is a craft handed down from father to son, generation to generation, mostly amongst dalit Muslims. All of Arshads fellow craftesmen are now labourers for big contractors which he puts down to the rise in plastic toys.

The case of toy makers from Udaipur is similar. 'A decade ago, 200 families made toys, lamp shades, flower pots and other products in Khairatiwada, in Udaipur. Now there are only 50.' says Bhola Ram Kumawat, a craftsman from Udaipur. [123, CSE] Of the total population of wood workers in 1981, 14.8 lakh, 8.7 lakh (59%) were located in rural areas. 41 year-old Sajjad Madni from Srinagar still makes the best papier-mache toys in the state but the craft may not last very long. Cheap plastic toys are replacing the hundreds of years old craft that he practices. Well-educated and articulate Madni loves his job passionately but is reluctant to let his sons enter the trade. There is absolutely no market for his goods in his native place. Price is an important factor as even the cheapest toy is about Rs100 ranging up to Rs8,000. The plastic toys in comparison are very cheap. But how is cost measured? A plastic toy may last a month, Madni's two generations. [124, Madni]

Effects of modernity

Other factors, than the rise of commodity plastics, have led to a steep decline in traditional rural industries and crafts. Acquiring raw material has become a major problem for India's 9.8 lakh potters, of whom 5.8 lakh are in the household sector (1981 census). Sources of clay, usually near water-points, are being encroached upon mostly for housing, industries or cultivation. And there are other factors that have caused the jute industry decline – poor management and lack of foresight being the main ones.

A key factor is the changing tastes – a new desire for modern western-based icons. The onslaught of a global culture conveyed by plastic satellites and cable to television has not only destroyed traditional entertainment such as puppetry, but also given new desires and aspirations to the growing middle classes. 'People prefer venetian blinds to bamboo chiks,' says Madan Singh. 'Venetian blinds are coloured, any colour you want.' [97, CSE]

8 Employment in petrochemicals and traditional industries

'The setting up of a petrochemical industrial base within the country will give an impetus to research and development efforts, besides providing jobs to a large number of scientifically/ technically trained personel... It gives rise to employment generation and scope for new entrepreneurial development.'

Government of India, Rakesh Mohan Experts Group Report on Petrochemicals, 1993

Plastic has been successful as the material of choice in the 20th century because one-shot automatic moulding operations eliminates the need and cost for separate fabricating, finishing and assembling operations. Automatic machinery replaces people, and companies such as Reliance Industries can boast of labour being only 2.7% of production costs as opposed to 35% for jute manufacture.

Plastics were developed at a time when machines were necessary because people were few in the northern industrial revolution. This model works where labour is in short supply, and resources are plentiful, which has been the case until recently in northern countries, particularly the US. As a model, it discourages employment and encourages use of resources. It is not effective in countries such as India with a 1 billion population where labour is plentiful, and resources increasingly threatened. The scales have tipped world-wide

since this model was born and now resources are few and labour plentiful, and ecologists in the north are pressuring for government policies that correct this growing imbalance. In particular fiscal policies that tax resources and not people.

Employment in traditional industries

Because of an absence of data, it is impossible to accurately assess the number of people who will lose their livelihood from traditional industry. But the estimate of 90% of 30 million people from the jute industry gives us an idea of the enormity of the unemployment potential.

The figures for artisanal work, of which an estimated 5% will remain in work supplying niche markets, have been collated as follows:

- There are about 15 lakh artisans engaged in the leather sector in India, of which 1 lakh consists of the urban/organised sector and 14 lakh the rural/unorganised sector. (These figures are the sum total of craftsmen engaged in tanning and flaying.) 1993/4 KVIC figures.
- 14.8 lakh, woodworkers, of which 8.7 lakh (59%) were located in rural areas. (1981 census)
- 8.2 lakh bamboo and fibre workers. The countries third largest group of artisans. (1981 census)

Rajni Bakshi calculated that, 'the artisan sector contributes Rs65,000 crore to India's GNP and earns approximately Rs15,000 crore in exports. The various Viswakarma communities – artisans working on textiles, leather, metals, wood, bamboo, stone and mud – are estimated to be about 2.5 crore families all over India.' [27, Bakshi] This means that approximately 10 crore people, or a little more than 10% of India's population, derive works from artisnal sources.

Employment in the plastic industry

Of course, there is a balancing equation – the number of jobs potentially in the plastics industry – jobs in feedstock manufacture, petrochemical processing, polymer manufacturer, plastic processing through to small-scale processing and re-processing.

Various government and industry bodies have estimated these numbers but, depending on source and method of calculation, several different figures are arrived at for primary, secondary and tertiary employment. Primary employment is usually defined as those employed directly by the industry, i.e. from the petrochemical industry to the downstream processors. Secondary will be those who are either contractors or suppliers of goods and services to the industry, for example, machinery manufacturers or marketing agents etc. Tertiary employment means those on the periphery of the industry, for example, agents, raw material and component supplier industries, ragpickers, those who run and work in shops selling plastic goods and those related to the ancillaries that are supplying parts and components.

Rakesh Mohan says that one of the perceptions of the petrochemical industry needs correcting: 'It is alleged that the petrochemical industry does not create adequate employment.' Capital employment ratio is generally calculated at Rs2 crore for one person, based on a complex employing 2,000 with a capital investment of around Rs4,000 crore. However, Mohan argues, this does not take into account the employment potential in the related areas – i.e. construction, processing, support services etc. He goes on to make a rough calculation to estimate numbers employed throughout the plastics industry.

> 'Though a modern world scale petrochemical complex gives direct employment to only about 2,000 people, the employment potential at the processing level is estimated to be about 5 persons per 10 tonnes of polymers. Thus, for 500,000 tonnes of polymers and elastomers from a complex the employment potential at the primary level is around 250,000. The employment potential in the secondary level of processing being twice that of the primary level, the potential works out to 500,000. Considering the employment in the tertiary level, including services etc at 2 persons for every tonne of plastics, the employment generation at this level would be 1 million people.' [9, GOI Mohan]

Based on these figures, to produce 500,000 tonnes of polymers per plant the total employment is 1.75 million, excluding the numbers employed in producing industrial chemicals. If we assume that the

industry will have expanded to 3 million tonnes of polymers by the beginning of this 21st century (Mohan anticipates 2.5 million, others 4 or 5 million) then we can deduce that there will be 6 x 500,000 tonne petrochemical complexes in India, or equivalent thereof. Therefore, according to this formula the total employed in the plastics industry in India will be 10.5 million people. This is probably not accurate and far too high a figure.

Mohans is a 'back of the envelope' calculation, and given the large numbers employed in the small scale and unorganised sector, (for example, in plastics recycling and ragpickers in India), it is impossible to accurately estimate numbers employed in plastics production. However, more precise, if contested, figures have been collated for the plastic processing sector.

Employment in plastic processing

Tata Economic Consultancy Services (TECS) were hired by the Plastindia Foundation to do a database and market study on the plastics processing industry. In February 1997, Plastindia Foundation published a booklet giving the relevant findings of the report. The census concluded that 11,306 active plastic units existed in India, employing a total of 172,320 workers (based on an average unit employing 15 persons).

Various experienced managers in the plastic processing had other opinions.

According to Mr. Duggad, a member of the Plastic Waste Management Task Force, the number of processing units should total not less than 20,000 nation-wide. Mr.N.S.Mani, Secretary of All India Plastics Association (AIPMA) and also Mr Vijay Merchant, former president of AIPMA, corroborate this figure. In fact, according to Mr Mani, the figure of 20,000 does not include a large number of units in the cottage industry. Mr Mani estimates direct employment in plastic processing is around 6.5 lakh.

Mr Vijay Merchant, who runs his own plastics unit and is well versed in the trade, calculates 10 skilled operators per average sized unit, therefore 200,000 skilled workers alone. Five times the estimated skilled workers or 1 million in total would be employed in scrap processing, die making units, machinery, additive manufacture and auxiliary manufacturing units.

On the other hand, Mr Vadodaria, an experienced marketing manager for NOCIL, thinks that industry estimates of the processing sector are exaggerated. His liberal estimates of processing units are in the region of 15,000 units. Direct employment he calculates would be in the region of 20 people per unit, with secondary employment in the ratio 1:1 and tertiary 1:3, the total would be 1,500,000 people.

Quantity versus quality

The Tata Economic Consultancy figures calculate that one third of those employed in the plastic processing units were in skilled work. The distribution is described in Table 16.

Table 16 Type of work and number of primary workers employed in plastic processing

Professional	22,760
Skilled	55,380
Semi-skilled	44,850
Unskilled	49,330
Total	172,320

Source: Tecs 1997

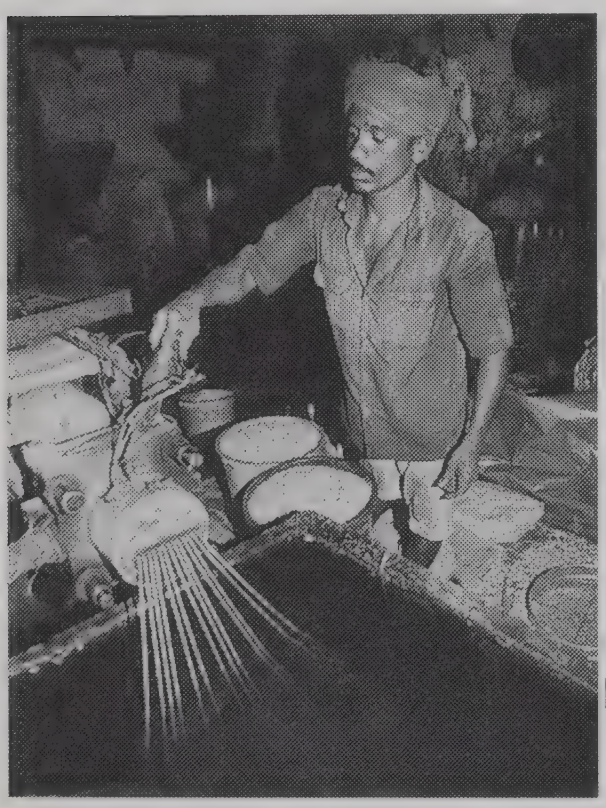
Whatever the true numbers employed in the plastic industry, it is certainly debatable if the expansion of the industry has provided the amount of high-skilled technical jobs envisaged by government planners. While there are 'skilled' jobs in the running of 'high-tech' polymer plant the bulk of work is in unskilled processing, recycling and scavenging.

The majority of workers in petrochemical processes, from polymer manufacture to plastics processing and small-scale processing to reprocessing operations, are routinely exposed to a range of health-threatening toxic chemicals. India is the world's seventh largest industrial nation, yet government and industry show a woeful lack of awareness and concern about chemical hazards, especially in the work place. Employers, especially in the large number of urban unorganised, small scale sector where much plastic recycling and reprocessing takes place, can exploit a situation where poorly paid jobs involving gross exposure to hazardous chemicals are considered better than destitution.

9 Hazards of plastics

'The phenomenal growth of the plastic industry ... has bought in its train growing social and environmental concerns, especially due to the non-biodegradable property of plastics.'

Government of India, Bhattacharya, 1993



The first disenchantment with plastics in the 1960s and early 1970s was primarily aesthetic and cultural – the so-called counter-culture in Europe and the US was concerned about plastics in the context of lifestyles and consumerism. Official concern about the health hazards of plastics for both workers and consumers first arose in the 1970s and in the last 30 years, it has grown exponentially. This has partly been through a qualitative leap and a quantitative growth. A qualitative leap in analytic chemistry methodology and technology has allowed us to identify and measure a much larger number of hazardous and toxic chemicals. For example, the presence of hazardous chemicals in water, soil and body tissues has been progressively measured at parts per million, then billion and now trillion. At the same time there has been recognition of the growth in the quantity of environmental problems and health effects arising from chemical exposure – from the use of hazardous chemicals in plastic production processes, their presence in products and contamination of the environment from their disposal.

The major environmental issue with plastics, as far as the Government of India is concerned, appears to be the materials' non-biodegradabale properties. Chapter Four, 'Plastics and the Environment' of the Bhattacharya report mentions only this

issue. Nowhere in the report are the hazards of plastic production, use or disposal discussed.

> '4. Environment: Global Issues
>
> 4.1.1 The phenomenal growth of the plastic industry in developed world coupled with their 'disposable' culture, have brought in its train growing social and environmental concerns, especially due to non bio-degradable property of plastics.' [43, GOI Bhattacharya]

This attitude is reflected in the mainstream Indian understanding of the environmental impact of plastics, and epitomised in the plastic carry bag. Plastic litter is perceived by many as the main environmental impact of plastics.

Rakesh Mohan, however, recognises that plastic production uses hazardous materials. At plant level, he recommends the adoption of standard safety procedures for protecting workers and the local community.

While all oil-based plastic production uses hazardous materials, in a hierarchy of hazard, PVC is clearly the most problematic in all stages of its 'life'. Its production and disposal create one of the most hazardous synthetic substances, dioxin. Neither the Rakesh Mohan or Bhattacharya reports mention dioxin. No mention is made of potential health threats from the use of PVC products. No Indian agency currently monitors for phthalates, additives used in certain PVC products to make them soft. These potentially hazardous chemicals, classed as a possible human carcinogen by the International Agency for Research on Cancer (IARC), can leach out of toys that babies chew on, like water from a sponge.

1970s scientific evidence

In late 1972 the US Federal Trade Commission investigated reports that polyurethane foam and other synthetics were more flammable than industry testing standards indicated. Several airline accidents in which dozens of passengers were asphyxiated revealed that many plastics released toxic fumes when burned. In some cases chemicals used as flame-retardants compounded the effect. The threat of toxic fumes from burning plastics extended beyond aviation into the everyday lives of people who had purchased polyurethane foam in furniture, bedding and automobile interiors and whose domestic surroundings contained dozens of other potentially dangerous synthetics.

In May 1973 the Federal Trade Commission filed a class-action suit against 26 material suppliers, the Society of the Plastics Industry (SPI) and The American Society for Testing Materials (ASTM) for making false claims about non-flammability or self-extinguishing properties of polyurethane and polystyrene foams. Within the next two years a study at the University of Utah's Flammability Research Centre confirmed that laboratory rats which could survive exposure to concentrated wood smoke would succumb to fumes from burning polyurethane.

Before the industry had time to recover from this blow, it received another that threatened to be even more serious. While most people could expect to avoid being in a fire, no one could avoid daily exposure to a plastic as common as polyvinyl chloride, PVC. By the middle of 1973, the newly organised Occupational Safety and Health Administration (OSHA) began investigating reports that workers in vinyl plants were suffering at an excessive rate from angiosarcoma, a rare cancer that affects the blood vessels in the liver. Sixteen vinyl workers had died of the disease since 1961. Another ten had died in Europe, where the correlation first came under investigation. Tests with laboratory animals confirmed early in 1974 that the carcinogen was vinyl chlorine monomer (VCM), the gas from which PVC was polymerised.

By all accounts, many chemical companies producing vinyl resin were lax about meeting even a minimal exposure standard of 50 parts gas per million parts of air (50ppm). It was not unusual for workers to descend unprotected into polymerisation vats to scrub them out and 6,000 American workers were routinely exposed to vinyl chloride gas. The health director of the US union umbrella body, the AFL-CIO, denounced vinyl producers for a 'barbaric attitude that death and disease are part of the sacrifice that must be made for food, clothing and shelter'. In October 1974, in the first major regulatory decision of its existence, OSHA mandated a new exposure standard of one part per million (1ppm), averaged over an eight-hour shift, with temporary exposure to five parts per million (5ppm), not to exceed fifteen minutes. Resin suppliers, mostly the major chemical companies, claimed the new standards would destroy a US$1.5 billion industry. Nevertheless, they managed to comply.

After OSHA's revelations, concern about vinyl extended beyond occupational workers. People living near processing plants began

questioning the cancer risk from uncontrolled discharges of gas over the years. Experts began speculating about exposure to vinyl monomer through the burning of discarded PVC at garbage dumps or the baking of automobile upholstery in the sun. The US Federal Food and Drug Administration (FDA) became concerned about vinyl monomer migrating from food containers. In May 1973 the FDA banned liquor bottles made of PVC for that very reason. Some evidence suggested the monomer also migrated into vinegar, apple cider, vegetable and mineral oils. In 1975 the FDA prepared a stringent 'non-detectable' vinyl chloride limit of less than 50 parts per billion (50ppb) for any food and drug packaged in PVC.

Worker exposure

All plastics, except most bio-based plastics, require the use of hazardous chemicals in their manufacture. Workers in the petrochemical and plastic processing industries are most at risk.

Rakesh Mohan makes a number of recommendations to minimise the impact of the use of hazardous chemicals on both the immediate environment of petrochemical complexes and on workers in India. He says, 'In a developing economy, industrial development is viewed as means of employment creation. There is no doubt that it is necessary to ensure that the work place is safe and to minimise the hazards posed by the use of hazardous chemicals'. He outlines the major components of a comprehensive Chemical Safety Package and further recommends: 'The petrochemical industry should establish a system of biological monitoring of health of personnel handling hazardous chemicals.' [9, GOI Mohan]

However, Mohan's concerns remain wishful thinking. There is little recognition that any health and safety problem exists in India in the petrochemical industry. It is generally acknowledged that worker safety and health conditions in Indian industry fall woefully short of what one might expect from the world's seventh largest industrial nation.

Polymerisation, the first stage of making plastics, typically takes place in closed systems, and is therefore not the most hazardous part of the production process. But even routine operations such as loading and maintenance can be dangerous. Workers in the least regulated small-scale processing and reprocessing operations

throughout India are most at risk. The potential chemical health threat to workers in plastic production has been summarised by John.B.Sullivan.

Table 17 lists the main combustion hazards that have been identified for the major classes of plastic.

Table 17 Thermal degradation products of some plastics

Polymer	Degradation product(s)	Hazard Carcinogen	Mucous membrane irritant	Respiratory irritant	systematic toxic
Polyethylene (PE)	Carbon monoxide				S
Polyvinyl chlorine (PVC)	Vinyl chlorine	C			S
	HCl		I	R	
	Phosgene		I	R	
	Dioxins, furans	C			
Polystyrene (PS)	Styrene				S
	Benzene	C			S
Fluoropolymers	Carbonyl fluoride		I	R	
	Perfluoroisobutylene		I	R	
	HF		I	R	
Polyurethane (PU)	Aldehydes, ammonia		I	R	
	Cyanide				S
	Isocyanates		I	R	
	Nitrogen dioxide			R	
Phenolic	Formaldehyde		I	R	S
	Aldehydes, ammonia		I	R	
	Cyanide				S
	Nitrogen dioxide			R	

Source: [125, Sullivan]

Occupational heath policies

In 1992 Mukhand Uplekar reported, 'Every fourth worker in Asia and seventh in the world is an Indian'. Concern about workers' health is reflected in the Indian constitution, which states that:

> 'The state shall, in particular, direct its policy towards securing that the health and strength of its workers, men, women and children, are not abused, and that citizens are not forced by economic necessity to enter avocations unsuited to their strength... and that the state shall make provisions for securing just and humane working conditions.' [126, Uplekar]

Risks for workers in the production of plastics

'Workers may have exposures to vapours and dusts containing chemical intermediates, polymers, and additives during loading, mixing, pelletising and maintenance operations. Plastic grinding may generate polymer dust, resulting in inhalation and possible combustion hazard.'

Manufacture of even the least toxic plastics, polyethylene and polypropylene can potentially harm workers. All thermoplastic materials must be heated during processing, and the temperatures required to achieve proper fluidity vary with the composition of the polymer and the additives. Overheating of plastics results in thermal decomposition and the release of oligomers, monomers and other combustion products. Workers may be exposed to the thermal decomposition products during accidental overheating, during processing or during clean out and maintenance operations. In addition, the burning of plastics during fires may present a health hazard to fire fighters and the general public. [125, Sullivan]

In 1983 the Indian parliament endorsed a National Health Policy committed to providing health facilities to all workers by the year 2000. This decreed 'In their respective spheres of responsibility, the central government and the states must introduce organised occupational health services to reduce morbidity, disabilities, and mortality'. Despite this recognition, Uplekar says, 'occupational health services in India are rudimentary, with a particularly poor information base. Official figures show gross under reporting of cases of occupational disease. The country's only occupational health clinic recently opened at the Central Labour Institute (CLI) in Bombay.... According to a survey of the chemical industries located in and around Bombay, over 90% have never utilised the institute's facilities'. [126, Uplekar]

The enforcement of law and worker protection is particularly weak, under-staffed and under-funded. As with pollution enforcement, it varies from state to state and it is dependent on the strength of the factory inspection service.

The inspector to worker ratio recommended by the Factory Advisory Service and Labour Institutes is 1 to 150. However, in Maharashtra, one of India's most industrialised states, the ratio is 1 to 218. With this ratio, the average number of factory inspections is low – most of the factories are visited once a year, while 16% are

not inspected at all. Accident enquiries are the main reason for initiating a factory inspection. Maharashtra has 21,000 industries, 650 of which are hazardous industries. The state has three medical factory inspector positions. At the time of Uplekar's research, two of these were vacant and the one employed inspector had no formal qualifications in occupational health. Furthermore, factory inspectors in India have limited power, for they are permitted only to enter a factory and take samples if needed. The inspectors cannot stop an operation directly, however dangerous it may be. [126, Uplekar]

Health problems are rarely, if at all, recognised. A.K. Bhatt notes:

> 'There is no systematic account of the incidence of occupational disease in the major industries... This sorry state is due to the gross negligence of the occupational healthcare system. Discussions with the all the following people – Chief Inspector of Factories, the Labour Commissioner, the Deputy Director of Industrial Hygiene, the Director of the Employees' State Insurance Scheme (ESIS), the Regional Director of the Employees' State Insurance Corporation and some trade unionists – to get the data on the incidence of the Occupational disease in Gujarat, one of the most industrialised states of India, drew a blank.
>
> According to these officials, there has not been a single case of occupational disease in Gujarat though 34.12% of its 4.13 crore population are industrial workers. Not a single worker has been paid compensation for disability or death caused by an occupational disease under the workmen's Compensation Act, 1923. The Chief Inspector of Factories himself has not been notified about the incidence of any of the notifiable diseases under the Factories Act, 1948. The situation is not much better in the other states.' [127, Bhatt]

The Indian Factories Act (1948, amended in 1986) is considered by most commentators as being totally unsatisfactory for protecting the health of workers.

> 'The criteria and standards resemble general measures with exposure limits based on arbitrarily relaxed versions of western standards. There are no obligatory provisions

> for employing a medical officer at a factory or conducting pre-employment or periodical medical assessment of the workers or maintaining records of the same, although, paradoxically, it is mandatory to submit information on occupationally notifiable diseases. Periodic assessment of workplace exposure and ambient pollutant levels are also not mandatory under the act. The end result of these problems is a dismal situation with regard to information, which is poor qualitatively and quantitatively, despite mandatory reporting provisions under the act.' [128, Durvasula]

Even with effective monitoring and in countries with a well-developed welfare and medical infrastructure, health effects on workers in plastic production are notoriously difficult to detect. A recent case in the UK amply illustrated this. A lawyer who eventually received large damages in an out-of-court settlement for two plastic workers because of ill health caused by their workplace said: 'I suspect cases like this are only the tip of an iceberg. Industrial exposure to solvents used in plastic manufacture has been going on for many years but there are still relatively few identified cases of injury. This is partly because many of the symptoms like mood swings, fatigue, memory impairment and impotence are common in the population at large, and doctors may not recognise a link with work.' The two men had spent their working lives manufacturing that seemingly most innocuous of plastics, cellophane. They suffered asthma, memory loss and mood swings. Both came in contact with chemicals such as carbon disulphide, toluene, formaldehyde and phosgene. These are hazardous chemicals either used or created in many plastic processing operations. [129, Guardian]

Worker exposure in the PVC industry

The Indian PVC industry claims, 'that a greater emphasis is being laid on the design and monitoring system to minimise vinyl chloride monomer (VCM) in the environment. As a result...the VCM exposure levels have been reduced from typically 1000ppm during 1945-55 period to 1-2ppm, with some plants below 1ppm'. [66, Dhuldhoya]

> 'In India, the 1986 Factories Act Amendment makes it mandatory for management of plants, operating any of about 50 groups of processes termed hazardous, to

disclose health risks and medical records to their employees. The amendment has, for the first time in India, established Threshold Limit Values for 120 substances. That's the good news. The not-so-good news is that, since the Amendment, whether or not the limit values have been exceeded has never been divulged to workers or challenged by unions.' [130, Dhara]

Toxic Secrecy

A reporter on the US Houston Chronicle found evidence of foul play in the ongoing debate about the health dangers to workers manufacturing the raw materials of PVC. He found one example of a doctor under industry contract who, 'extremely unusually', reversed his damaging conclusions in a study of worker deaths involving vinyl chloride. Another investigation has shown that an epidemiological study of vinyl chloride workers, which began in 1973 and is being updated a third time, had major shortcomings from the start. Older, highly exposed workers were left out, as were entire plants. Younger workers with little or no exposure were included. Exposures were misclassified. [133, Morris]

Although in years 1974/5 levels of exposure to VCM in the workplace were substantially reduced, the problem of excess numbers of cancers in workers in the US PVC industry remains. Men working in PVC plants, now reaching their 50s, are dying in unusual numbers from unusual cancers.

Frequency of pancreatic cancer in workers at the Monsanto factory in Indian Orchard, Massachusetts was found to be five times the national average. In this case, studies done by The National Institute for Occupational Safety and Health (NIOSH) contradicted Monsanto's own findings.

Even if polymer workers nowadays are less exposed to VCM, science has recently indicated a new cancer hazard for processing workers. In an epidemiological study a Swedish scientist found the strong suggestion of a link between workers' moulding, grinding and polishing PVC to make final products, and the probability of contracting testicular cancer. The data indicate a high odds ratio of 1:6 for the risk of testicular cancer in those exposed to PVC. [131, Hardell] Other health affects have been identified in the US. In

1997, a US study found workers in PVC manufacturing to have a higher incidence of skin disease. [132, Socie]

The petrochemical industry in the US is as much 'in denial' as its counterpart in India. Industry in the US has fought strongly to limit its financial liability for deaths in PVC factories. Scientific studies that strongly link rare cancers in the workforce to PVC production are usually dismissed by industry as a result of chance rather than a chemical cause.

PVC: the poison plastic

After polyethylene (PE), polyvinyl chloride (PVC) is now the second most common plastic world-wide. In India PVC claims the largest share (28%) of the market. Of all plastics, PVC generates the most concern about the threat to the environment and health. Citizens groups, environmentalists, doctors and some scientists in the north continue to protest about its continued production, use and disposal.

PVC differs from other commodity plastics in the amount and variety of toxic additives used in its various applications, and that 57% of PVC is made from chlorine (the rest hydrogen and carbon). Additives used in PVC include heavy metals such as lead, cadmium or organotins as stabilisers, phthalates as softeners, and chloroparaffins, used as fire retardants.

The use of chlorine as the principle feedstock for PVC poses numerous environmental and human health problems. When elemental chlorine combines with carbon, for example, and when chlorine in water combines with humic matter, it creates a new range of chemicals called organochlorines. These are often extremely stable chemicals that can be highly toxic. Many persist in the environment and our bodies and bio-magnify as they move up the food chain from microorganisms to the higher mammals. In humans they can cause cancers, foetal death and spontaneous abortions, low birth weight and reduced birth size, altered behaviour, lower intelligence and disruption of the hormone system. [134, Edwards]

Dioxin

Dioxins are the most dangerous of organochlorines. They are only created in the presence of chlorine, carbon and oxygen, for example they are generated as by-products during the manufacture and combustion of PVC, in addition to numerous other toxic and persistent organohalogens.[5]

In February 1997, after years of debate, the most potent of dioxins, TCDD, was classified by the International Agency for Research on Cancer (IARC) as a known human carcinogen. Other health effects linked to dioxin exposure include endometriosis, birth defects, decreased fertility, immune system suppression, developmental and reproductive effects and disruption of the hormone system. In September 1994 the US Environmental Protection Agency (EPA) released a draft reassessment of human health risks from exposure to dioxin. The document warns that dioxin poses a large-scale, long-term threat to public health; the low-levels of dioxin present in the body tissue of the entire population of the industrialised countries in the north are already sufficient to trigger serious health problems, especially to the unborn. [135, Duchin] This is a frightening human health threat, invisible and rarely considered by most governments and the medical establishment.

In the world of synthetic chemicals, dioxins are among the most deadly and the most feared. Laboratory tests have shown dioxin to be thousands of times more lethal than arsenic to guinea pigs, who died after swallowing only one-millionth of a gram per kilogram of body weight.

Dioxins are produced as unintentional by-products from the many processes in which chlorine and chlorine-derived chemicals are produced, used and disposed of. Since about 30% of world chlorine production is used to make PVC, then PVC production is perhaps the single-most important source of dioxin. (Table 17) Even if

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[5] 'Halogens are a group of reactive elements including fluorine, chlorine, bromine and iodine. Fluorine and chlorine are gases at room temperature, bromine a volatile liquid and iodine a volatile solid. Their occurrence as free elements in nature is limited to the most extreme circumstances (e.g. volcanoes). They are most commonly present in the form of inorganic metal salts (including common salt, sodium chloride) or as charged halide ions in aqueous solution (e.g. in the sea). In this form they do not react readily with organic carbon compounds which form the building blocks of life. But as organo (i.e. organic) halogens they can last for a long time in the environment, including building up in body tissues where they can cause cancers and other serious health problems.'

creation of dioxins ceased now, levels in the environment would take years to decrease. This is because dioxins are persistent, taking decades to degrade, and can undergo continual cycling throughout the environment.

Human exposure to dioxins is almost exclusively from food intake, especially from meat, fish and dairy products, which tend to accumulate dioxins from the environment because of the high affinity these chemicals have for fats and oils. In fish, mammals and humans, evidence shows that the developing foetus is most a risk. Animal experiments have shown that very low doses of 2.3.7.8-TCDD at critical times during gestation are enough to cause a reduction in sex organ weights, a decrease in sperm count and effects on sexual behaviour. The same dose had no demonstrable effect on the mothers.

Toxicity of Dioxin

The United Nations Environment Programme (UNEP) has listed dioxins as a persistent organic pollutant for priority phase-out.

The term dioxin usually refers to a whole chemical family with 75 individual members, which more correctly should be termed chlorinated dibenzo-p-dioxins. The most toxic member of this family is 2.3.7.8-Tetra-Chloro-Dibenzo-p-Dioxin, often abbreviated to 2.3.7.8-TCDD. This compound is what the term dioxin usually refers to.

Often the term dioxins also include a closely related chemical family called chlorinated dibenzofurans. The most toxic among the 135 known furans is 2.3.7.8-Tetra-Chloro-Dibenzo-Furan (TCDF), which is one tenth as toxic as the corresponding dioxin TCDD.

Of the 210 dioxins and furans, 12 are extremely toxic. Comparing them to 2.3.7.8-TCDD via internationally agreed upon Toxic Equivalence Factors (TEF) ranks their individual toxicity. The factor thus obtained for each substance is multiplied by its amount or concentration and the results added together. The total is called 'TCDD equivalents', or TEQ.

Table 19 Summary of dioxin sources and their chlorine donors

Dioxin generating process	Primary chlorine donor
Municipal waste incineration	PVC, bleached paper, household hazardous waste
Medical waste incineration	PVC
Pulp Mills	Chlorine based bleaches
Hazardous waste incineration	Spent solvents, chemical industry wastes, pesticides
Wood burning (Industrial and residential)	PVC, pentachlorophenol, and chemical hardeners
Secondary copper smelting	PVC-coated cables, PVC in telephones and electronic equipment, chlorinated solvents/cutting oils
Chemical manufacturing	Chlorine or organochlorines as a reactant
Home and building fires	PVC, pentachlorophenol, PCP's chlorinated solvents
Vehicle fires	PVC, chlorinated cutting oils
Ferrous metal smelting	PVC, chlorinated cutting oils, chlorinated solvents
Vehicle fuel combustion	Chlorinated additives
Forest fires	Pesticides, deposition of airborne organochlorines
Sewage sludge incineration	Chlorinated by-products
Secondary lead smelting	PVC

Sources: EPA 1994b, Versar 1996, Thomas and Spiro 1995, Dempsey and Oppelt 1993, Wiken 1994, Heidle and Hutzinger 1987, Marklund 1990, Tyskind 1989, Aittola 1990, Green 1993, Brzuzy and Hites 1996.

Dioxin in India

In May 1996 Greenpeace sampled the effluent and sediments contaminated by chlorine and PVC production of Chemplast Sanmar at Mettur Dam in Tamil Nadu. Although no quantitative analysis was done, chemical compounds that are typical precursors to dioxin were found in sediments. [134, Edwards] Industry reaction was that of simple denial that PVC production could create hazardous chemicals. A press release of the Plastindia Foundation, a public relations body of the plastics industry in India, published verbatim in the Hindustan

Times, stated: 'Production of PVC is extremely safe and substances like VCM and EDC are handled with complete safety during PVC production. The latest closed-loop systems are completely safe and closely monitored by environmental protection agencies the world over'. [136, Hindustan Times]

Given the small amounts of PVC produced in India relative to the size of population, the human 'body burden' of dioxin must be much lower compared to the industrial nations of the north. However, open burning and melting of PVC plastic in small scale reprocessing and recycling operations must contribute significantly to amounts of dioxin generated in India – these industrial operations would not be allowed in the north. With the planned expansion of the industry and uses of PVC, the dioxin problem is bound to grow.

Some of the major producers, such as Reliance and Finolex avoid part of the dioxin problem in primary production of PVC by importing their EDC and VCM, the raw materials of PVC. They import from countries in West Asia or the Gulf of Mexico States of the US, home of the world's largest PVC producers. Here energy prices, the biggest cost in PVC production, are much lower than in India.

Even after PVC products are sold, they produce dioxins if they encounter reactive conditions, for example, when a building or product containing PVC burns in a fire. Incinerators or smelters in which waste PVC is burned are significant dioxin sources. The unknown quantities burned in industrial and warehouse fires, automobile fires, metal smelters, backyard burning and wood combustion add to this total.

In India recycling of plastics often takes place in congested, unregulated markets in the major towns. On June 6th 1995 a devastating fire swept through the Jawalapuri plastic market, near Nagloi in West Delhi. The scorching heat of the peak summer temperatures of about 40 degrees centigrade, and the hot strong wind added to the fury of the inferno. Over 2,500 shops stacked with PVC and other scrap plastics were gutted. These were ideal conditions for creating large amounts of dioxin. Yet in its report on the incident The Central Pollution Control Board did not mention the word dioxin. It listed 'probable gaseous emissions on burning PVC' as including 'chlorine, vinyl chloride, ethylene dichloride, phosgene, hydrogen chloride,

carbon monoxide etc'. [137, CPCB] Dioxins would more likely be part of the particulate emissions which were probably not considered or tested for by the CPCB.

Neither the Central Pollution Control Board nor the State Pollution Control Boards nor, as far as we know, the PVC industry in India, does any testing for dioxins. However, there is some evidence that government authorities are acknowledging the dioxin problem arising from burning PVC. The incineration of PVC medical waste was banned in 1998 by the Ministry of Environment and Forests (MOEF) through the Bio-Medical Waste (Management and Handling) Rules.

Play Safe – phthalates in PVC Toys

More recent concern about PVC has focused on the health threats from additives used to make PVC soft and pliable, known as phthalate plasticisers. PVC is the only plastic that requires the use of large quantities of additives. In the last 3 years an increasing number of governments, retailers and toy manufacturers throughout the world have restricted or voluntarily withdrawn the sale of PVC toys.

Phthalates are known to present a number of hazards. The adverse effects in laboratory animals include damage to the liver, kidneys and reproductive systems and cancers. Phthalates can constitute up to 40% by weight of soft PVC toys and since the phthalate isn't bound to the plastic it can leak, or leach out over time. When a child chews or bites on a toy, it increases the rate that the phthalates leach out, much like squeezing on a sponge.

In 1999, the Danish Minister for Environment and Energy, Sven Auken, presented an overall strategy to clear the Danish environment of PVC, and a new action plan to reduce and phase-out the use of plasticisers. This strategy annulled the voluntary agreement concluded in 1991 between the former Minister for the Environment and Industry. Sven Auken, released this statement:

> 'We know today that the use and disposal of PVC gives rise to a number of serious environmental problems. We also know that some of the phthalates may impair our reproductive capacity and possibly cause cancer. In the long term they also harm the aquatic environment. A ban

> has already been introduced against applications involving the most serious health risks, i.e. in toys and products for small children. The new phthalates action plan enables us to strengthen our efforts to reduce and phase out the use of phthalates. The new strategy puts an end to the voluntary approach, but not necessarily to the dialogue with industry. A broad range of instruments will be used: bans, charges, technological development, more innovation etc. International efforts will also be strengthened – for instance in relation to major pollution sources like undercoating of cars, and PVC textile printing.' [138, Danish EPA]

The main problem for the consumer is that it is extremely difficult to identify which toys are PVC and which are not, since no labelling is required at present. Sometimes a toy will be labelled as vinyl, or even 'safe, non-toxic vinyl', and in some European countries toys are now labelled, 'PVC free'. For the vast majority of the world, consumers are best advised to avoid soft plastic toys altogether.

Indian toys analysed

In 1996, Greenpeace began a 'Play-safe' campaign, to stop toy manufacturers using harmful additives in their products. As a result of this campaign many of the world's leading toy manufacturers have ceased using PVC in a range of their products. Governments have responded positively by banning these toys. Some governments are even re-considering their overall strategy towards harmful chemicals, described in Annex 2.

After major toy manufacturers refused to give Greenpeace any information about the chemicals that were used in their plastic toys, Greenpeace undertook its own scientific investigation. A total of 71 toys were purchased from 17 countries, including 5 from India, and analysed at Greenpeace Research Laboratories at Exeter in the UK. 63 were made of soft PVC or had soft PVC parts and almost all of these contained significant quantities of phthalates. Extraction and analytical procedures were carefully quality controlled using a USEPA method for the analysis of phthalates. [139, Stringer]

There were 5 PVC toys from India analysed: an inflatable red duck bought from a street vendor at The Gateway to India, Mumbai,

two teethers, one PVC doll and one soft animal, bought from shops in Colaba, Mumbai and Defence Colony Market, South Delhi. These toys are available throughout India and are usually purchased by higher income families. All but one toy was manufactured in India.

In almost all of the soft toys analysed, phthalates comprised a sizeable proportion, most frequently between 10-40% of the total weight of the toy. One teether and the inflatable duck contained the phthalate ester di (2-ethyhexyl) phthalate, commonly known as DEHP (11.4% and 13.9% DEHP of the weight of the toys respectively). The doll contained phthalates known as DnBP and DiBP. The other teether contained a much lower weight of DEHP. The remaining animal toy contained unidentified additives.

DEHP

DEHP was once the most commonly used phthalate in PVC and the majority of toxicological and other research on the phthalates has been carried out on this compound. Initially assessed as having fairly low toxicity based on acute exposure studies in laboratory animals, it is now recognised that DEHP can exert a number of chronic effects following longer exposures and may be an important reproductive poison. [140, Life Systems] More recently concern has been raised about the ability of DEHP and some other phthalates to interact with hormone receptors in animals. Laboratory research on the health effects of phthalates generally has identified wide-ranging chronic effects. These include liver and kidney lesions, reproductive abnormalities, including testicular atrophy, altered development of reproductive tissues and subtle effects on sperm production, cell line transformations, and cancers, including those of the liver, kidney and mononuclear cell leukaemia.

These results have serious implications for domestic consumers and international markets. Plastic toys and games are a growing export sector of Indian industry and in 1997-8 exports of these products leapt 149.66% to a value of US$3.62 million. [115, Financial Express]

In 1980, The International Agency for Research on Cancer (IARC) declared DEHP a probable human carcinogen. In 1986, following a US Product Safety Commission investigation into health risks from DEHP exposure, the Toys Manufacturers of America accepted a

voluntary standard which allowed no intentional addition of DEHP into pacifiers, rattles and teethers (a maximum 3% by weight). Market reports have shown that uses of DEHP have been replaced in most of the world, except in India, by diisononyl phthalate (DINP) which in its turn has been shown to produce tumours and a range of other chronic effects in laboratory animals.

Soft PVC in India

Toxic toys are not only being made in India, but also imported, and sold unhindered in the toy shops in India. The big global players in the toy business that have a presence in India include Mattel, Hasbro and Little Tikes, but other brands come from China and other Asian countries like Thailand. Market analysis says that the future for toys, including those made of soft PVC, is 'bright' in India where current annual per capita expenditure on toys is 1cent compared to US$35 in the US.

Particularly alarming is the fact that no Indian government agency has been monitoring toys (indigenous or imported) for phthalates or complex toxicity. The Bureau for Indian Standards (BIS) evidently has standards for toy safety relating to their mechanical and physical form as well as some elemental toxicity, but there is little enforcement and manufacturers do not even bother with getting a certificate. 'We do not have the facility for checking PVC constituents. The only thing we check for is the presence of mercury, cadmium and arsenic', said Lajinder Singh, Director of BIS.

In Europe and the US, consumer pressure led by Greenpeace coupled with growing scientific evidence has been successful in banning phthalates in childrens toys. As described in Annex 2, by the beginning of 2000, the major toy manufacturers stopped using phthalates in toys for children under 3, and many have stopped using PVC altogether. Mattel has not only committed to phase out all use of PVC in its products, but move into bio-plastics.

Standards are needed in India for indigenous and imported toys. Standards for additives and labelling. But how can they be set and enforced in the multitude of unorganised small-scale plastic reprocessing and recycling operations in the alleyways and jhuggis of metropolitan India?

Alternative plastics to PVC

A new generation of polyolefins is now in production in the north that could replace soft PVC in toys and other products. Materials such as VLDPE (very low-density polyethylene), UDPE (ultra) and LLDPE (linear). Thermoplastic elastomers (TPEs) have been created that exhibit rubber like qualities, are tough and durable and also do not require additives. Ethyl vinyl acetate (EVA) is another alternative. It is tough, resilient and flexible, although it still contains leachable chemicals, additives and contaminants. Metallocene PE products have a big advantage over PVC in that their low density allows as much as 40% reduction in weight per part. They have a lower processing temperature and much lower injection moulding time (25% less) than PVC. The resins are also much more thermally stable than PVC. It has been estimated that the savings in terms of cost per part over PVC are in the range of 25-30%.

There is no evidence that India is investing in these better plastics. Investing in traditional materials, especially for children's toys, would be more sustainable solution. This is especially true in the case of India, where, as we have seen, the skills of craftspeople in village economies are still alive, albeit under threat from the petrochemical industry. Not only would using traditional materials ensure a livelihood for many traditional workers, keep traditional skills alive, and remove the necessity of urbanised factory work; in purely economic terms, it would avoid the heavy costs of research, investigation and monitoring that is required by the hazardous nature of plastics.

Hierarchy of plastic's hazards

All plastics create environmental and health problems throughout their lifecycles. Some are worse than others are.

Table 20 Pyramid of plastics ranked by hazard

Polyvinylchloride (PVC)
Polyurethane (PU) Polystyrene (PS) Acrylonitrile-butadiene styrene (ABS) Polycarbonate (PC)
Polyethylene-terephthalate (PET)
Polyethylene (PE) Polypropylene (PP) Thermoplastic elastomers
Bio-based polymers

Source: Greenpeace International 1994

Polyvinyl Chloride (PVC)

At the top level is PVC for the dangers it presents throughout its lifecycle, as already described in some detail, from manufacture through processing and use to disposal.

Polyurethane (PU)

Polyurethane is mainly used in insulation and soft/foamed products like carpet underlay. Its production consumes about 11% of the world-wide chlorine production, using chlorine as an intermediate, not in the end product. It uses several hazardous intermediates and creates numerous hazardous by-products, including phosgene, isocyanates, toluene, diamines, and the ozone-depleting gases methylene chloride and CFCs, as well as halogenated flame-retardants and pigments.

PU production has been linked to occupational health problems, including isocyanate-asthma, which is a life threatening disease. [143, Danish Technological Institute] Due to PU's problematic production processes, the Danish Environmental Protection Agency concluded

that isocyanates result in considerable disadvantages in the work environment. Several chlorine-free production routes for PU have been developed. [144, Hessischen Ministerium fur Umwelt] These are an environmental improvement, but the alternative processes still use hazardous isocyanates as intermediates.

According to industry, flexible PU foam is recyclable into new high quality flexible foam products. However, recycling is predominantly with virgin PU foam scrap, as very few flexible PU recycling processes use post-consumer waste. [144, Hessischen Ministerium fur Umwelt]

The burning of PU releases numerous hazardous chemicals such as isocyanates, carbon dioxide, hydrogen cyanide, Polycyclic Aromatic Hydrocarbons (PAHs) and dioxins. Dioxins and other halogenated compounds are produced if CFCs or halogenated flame-retardants are present. In landfills, PU ester foams have been observed to degrade, generating and releasing ozone destroying CFCs and HCFCs. [143, Danish Technological Institute]

Polystyrene (PS)

Polystyrene is widely used for foam insulation and also for hard applications like cups and toys. Its production involves the use of known (benzene) and suspected human carcinogenic substances (styrene and 1,3-butadiene). The carcinogenic styrene oxide is reloaded during processing and other raw materials are reproductive toxins. [143, Danish Technological Institute]

PS can technically be recycled, but recycling rates are low, although still higher than for PVC.

PS poses significant fire hazards. For example, it played an important role in starting the Dusseldorf Airport fire in 1996. [145, Weinspach] Styrenes and PAHs will be formed during the burning of PS, and hydrogen chloride and dioxins are released if brominated or chlorinated flame-retardants are present.

Acrylonitrile-butadiene-styrene (ABS)

ABS is used as a hard plastic in many applications like pipes, car bumpers and toys (hard building blocks). ABS uses a number of hazardous chemicals during manufacture, including butadiene and styrene and acrylonitrile.

Acrylontrile is highly toxic and readily absorbed by humans by inhalation and directly through the skin. Both the liquid and its vapour are highly toxic, displaying many of the characteristics of cyanide. The vapour is heavier than air and may cause severe eye irritation, headache and nausea. Acrylonitrile, styrene and butadiene are all classified as probable human carcinogens [146, Coode Island Review Panel]. Additives include antioxidants (to prevent auto-oxidation) and light stabilisers, pigments, protective coatings and film. Flame-retardants include antimony-based and halogen-based compounds. Because of its many composites, ABS is extremely difficult to recycle.

Polycarbonate (PC)

Polycarbonate is used for products like CDs and refillable milk bottles and is usually made with the highly toxic phosgene – derived from chlorine gas.

PC does not need additives but uses solvents for its production, such as methylene chloride (a carcinogen), chloroform, 1,2-dichloroethlylene, tetra-chloroethane and chlorobenzene. New non-chlorine PC production processes are being developed which would avoid using chlorine, phosgene and some chlorinated hydrocarbons. However, these chlorine-free processes also involve the use of Bisphenol A, an endocrine disrupter. This has been shown to leach from polycarbonate flasks during autoclaving and from food-ware such as polycarbonate baby bottles. [144, Hessischen Ministerium fur Umwelt], [147, Raloff]. Recent research (see Chapter 9) shows this to be one of the most potent disrupters of hormonal systems. The fact that Bisphenol A is used for lining process food cans means that it is now part of the body burden of a great number of women in the world, who unwittingly pass these dangerous chemicals to the unborn.

Recently a new chlorine-free synthesis route for polycarbonate has been developed, based on oxidative carbonisation using phenol instead of bisphenol A. This new route is a significant improvement of polycarbonate's environmental profile, avoiding chlorine, phosgene and bisphenol A. The introduction of this process would move polycarbonate down the pyramid of dangerous plastics.

Polycarbonate cannot be recycled back to the same product. However, a number of processes have been developed to reclaim it from compact discs and PC milk and water bottles. The polycarbonate is then down cycled into lower quality products such as carrying crates or building applications, or for mixing in small quantities with virgin material for higher-grade products such as bottles. [79, Ram]

Polyethylene-terephthalate (PET)

PET, made from ethylene glycol and dimethyl terephthalate, is commonly used in packaging, for example bottles. It often contains additives (up to 30%) such as UV stabilisers, pigments and flame-retardants. [143, Danish Technological Institute] In the production of PET, a number of substances are used which can cause irritation to the eyes and respiratory tract, and there is a small excess of cancer incidence. Heavy metals may be used as a catalyst during production and end up in the environment. However according to the Danish Technology Institute, compared to PVC, PET has fewer risks for the workers and the environment, reduced risk of accidents and advantages in waste management, including greater prospects for recycling. [143, Danish Technological Institute] PET recycling rates are high compared to those for other plastics.

Polyethylene/Polypropylene (PE/PP)

The Polyolefins such as PE and PP are simpler polymer structures that do not need plasticisers, although they do use additives. PP is often made using a chlorine intermediate process, though a viable non-chlorine process exists and which would have less environmental and health impact.

The raw materials, ethylene and propylene, are highly flammable and explosive, but relatively harmless for the environment.

Halogenated flame-retardants are sometimes used in polyolefins as additives, but these are being replaced by more environmentally acceptable flame-retardants, such as aluminium and magnesium hydroxides. Other additives include UV and heat stabilisers and anti-oxidants. Newly developed catalysts for their production are further enhancing their widespread applications. The burning of polyolefins can generate many volatile compounds, including formaldehyde and

acetaldehyde, both suspected carcinogens. [143, Danish Technological Institute]

Nevertheless, the polyolefins pose fewer hazards than other plastics throughout their lifecycle and have the highest potential for mechanical recycling. PET and PE could replace other plastics, especially PVC, in the intermediate term. However their inability to fit within clean production criteria ultimately means they are less desirable than bio-based polymers and traditional (indigenous) materials based in sustainable production and use.

Thermoplastic Elastomers etc

Other plastics at the lower end of the pyramid of hazard are a range of copolymers (two different plastics linked together) often mixtures of PE and PP with other materials. These copolymers are often referred to as thermoplastic elastomers. Thermoplastic elastomer (TPE) is a material that combines the processability of a thermoplastic with the functional performance of a conventional thermoset rubber. This allows processing of flexible rubbery articles with speed, efficiency and low costs. These materials match or better the characteristics of flexible plastics in terms of strength, appearance and performance. Some of these include ethylene-propylene elastomers (EPM) and ethylene-propylene-diene terpolymers (EPDM). EPDM poses some problems because butadiene (a probable carcinogen) is used in its production process, but the process is essentially closed and poses relatively little potential for exposure.

Advancements in catalyst research have led to the development of metallocene polyolefins. The metallocene catalysts allow the precise and predictable tailoring of process chains to import a range of qualities on the polymer with a minimal use of additives.

Ethyl vinyl acetate (EVA) is another new plastic replacing soft applications. The characteristics of this material can range from the thermoplastic to elastomeric state, depending on the vinyl acetate content of the co-polymer. In theory, EVA does not need a range of additives. However, samples recently analysed by Greenpeace's Research Laboratories at the University of Exeter in the UK contained a cocktail of toxic substances at low levels.

Of course, a problem with all of the petrochemical-based plastics production processes is their flammability, which poses a severe accident risk to neighbouring communities. Being petroleum-based,

the cracking of hydrocarbon feedstocks generates persistent organic pollutants, such as polycyclic aromatic hydrocarbons (PAHs). [148, Norsk Hydro]

Biodegradable polymers

Biodegradable plastics are defined by the International Standards Organisation (ISO) as plastics which degrade from the action of micro-organisms such as bacteria, fungi and algae. Biodegradable plastics can still be petroleum based and should not be mistaken for bio-based plastics.

EVA and several other of the less harmful plastics can be made biodegradable by creating weak links in the polymer chain so that bacteria and other micro-organisms can break it down into smaller pieces relatively quickly. While this is an important first step, biodegradable plastics cannot be considered a de facto environmentally safe replacement for other plastics, as they still contain constituents of conventional plastics, including additives etc, and they do not fully bio-degrade.

Bio-based plastics

Bio-based plastics or bio-polymers are biodegradable plastics made from renewable sources, products obtained from raw materials produced by a natural living or growing systems, such as starch and cellulose, or those made via biotechnological processes. [149, Smits] Natural polymers include cellulose (from wood or cotton), horn (hardened protein) and raw rubber. Converted natural polymers include vulcanised rubber, vulcanised fibre, celluloid and casein protein.

Bio-based plastics are a potentially sustainable alternative to petroleum based materials, and particularly for plastic products that have a short use-life or are impractical to recycle, such as food packaging, agricultural plastics and other disposables. They are made of renewable materials. They avoid the problems of the hazardous additives. The degradation products can be re-used (methanol, methane) and the biomass can be down cycled to soil-carbon, which leads to a closed carbon cycle. [149, Smits]

10 Plastic waste and recycling

'Legislation has been/is being enacted to curb wastage. The report highlights this area of concern, as in India waste recycling very much forms part of the economic activity, providing gainful employment to poorest section of the society.'

Government of India, Bhattacharya, 1993

'Autopsies of cows in the capital (New Delhi) have found the stomachs of cows stuffed with as much as 110 pounds of plastics. The animals die a slow, painful death from convulsions.'

Associated Press, 7th September, 1998

In India where traditionally every material is re-used, or organically goes back to the earth from where it came, plastic litter has become a visible anathema in both urban and rural areas. It is an unnatural addition. Our human race, as Professory Barry Commoner commented in 1971, had 'broken out of the circle of life, converting its endless cycles into man-made linear events'. Nature had no mechanisms for breaking down 'literally indestructible plastics and integrating them into its eternal cycles'. It is 'sobering to contemplate the fate of the billion of pounds of plastic already produced, some of it incinerated, thus polluting the air, some of it dumped in the oceans and harming marine life, the rest of it straining landfills or strewn across the landscape'. [29, Meikle]

Both Indian government and industry propose that the answer to the growing volume of plastic waste is recycling. Certainly India has a commendable recycling culture, and one of the highest rates of recycling plastic in the world. It's a solution that in theory removes the eyesore, and generates employment.

The employment it offers is to an army of the destitute who collect the plastics and back-street recyclers who are exposed to a variety of hazardous chemicals with long term health effects. The type of plastic 'recycling' as practised in India is not recycling, as most people understand the term. It is another appropriation of language. Recycling in India is 'down-cycling', making inferior products out of plastic waste. It is hazardous, pushing the toxic burden of the material into secondary markets.

All schemes that are proposed by government or citizens to deal with plastic waste - recycling, take-back, banning, labelling - are dominated and thwarted by the plastic industry lobby. It successfully avoids taking responsibility for the products it has created. Not one of the initiatives for dealing with plastics waste in India, including the type of recycling industry and government promotes, will diminish the flow of virgin plastic onto the market.

The ubiquitous plastic bag

For most Indian citizens the environmental problems of plastic have focused on the most visible non-biodegradable plastic waste, the plastic carry bag. In the words of environmentalist, Ravi Agarwal, 'Omnipresent, the plastic carry bag has strewn itself everywhere. In gardens, parks, drains, garbage dumps, on branches of trees and even in bird nests, it can be found to exist, propagating almost like a life form. Light and flimsy, the ubiquitous carry bag floats around in a light breeze, finding new places to litter and inhabit forever'. [151, Agarwal]

When the Indian Express newspaper conducted a survey asking what are the most harmful effects of plastic use, the answer came back loud and strong: clogged drains. [152, Sharma] A mayor of Delhi, Sakuntia Arya once said, 'If I had my way, I would enforce a total ban on polythene bags. They keep on accumulating in the drains and are a perennial source of irritation'. [153, Hindustan Times][6]

[6] Many NGO's in Mumbai are campaigning to ban the plastic bag, including the Bombay Natural History Society (BNHS), Nirmala Niketan, Sanctuary, The World-Wide Fund for Nature (WWF), Beauty Without Cruelty, Save Bombay Committee and Bombay Environmental Action Group (BEAG).

And it's not just an urban problem: 'In rural areas people have no provision for recycling. In villages, people mix these polythene bags with cow dung without considering the drastic consequences. When these polythene carry bags are spread on the fields, they adversely affect the fertility of the soil – no seed can germinate on land where plastic bags are dumped thoughtlessly. The layer of plastic waste harms the permeability of the soil, and the water conservation capacity of the soil gets decreased. The plant roots cannot get proper minerals. It also hampers the air circulation of the soil. In this way plastic wastes will make our land barren and infertile.' [154, Yadav]

Attempts to ban plastic bags

Various attempts have been made to stop the use of plastic carry bags and other waste plastic products. 'Country-wide NGOs are campaigning to 'say no to plastic bags' particularly in schools. Some 200,000 schoolchildren in Delhi are spiritedly spurning polybags in for eco-friendly alternatives', say activists. At the start of a new school year, a 12-year-old girl in west Delhi insists on buying a jute schoolbag. Another child has convinced his mother to pack sandwiches in a cloth napkin because 'plastic is a major environmental hazard'. [155, Kaur]

Naval institutions have prohibited plastics from being carried into their compounds. 'Sabarimala, Kerala's major pilgrim shrine, and Kerala State's zoos and museums have banned the carrying of plastic bags and containers on their premises. All eateries, canteens and coffee stalls have been asked not to use plastic cups and wrappers. Visitors are searched for plastic items at the gate and those found violating the ban order would be penalised. Environmentalists in Kerala have welcomed the government steps and have asked for a similar ban on plastics in milk packaging and in shops'. [156, Times of India]

In Delhi lawyer B.L. Wadhera filed a public interest lawsuit seeking a ban on the manufacture of plastic bags. B.L Wadhera says, 'the cheap bags contain chemicals such as cadmium or lead that are harmful to health. They leach into vegetables, meat and food. Given India's poor garbage collection facilities, tonnes plastic bags litter the roads, preventing rainwater from seeping into the ground. Hundreds of cows die in New Delhi alone each year when they choke on plastic bags while trying to eat vegetable waste stuffed in the garbage

bags. Autopsies of cows in the capital have found the stomachs of cows stuffed with as much as 110 pounds of plastics. The animals die a slow, painful death from convulsions, a recent government study revealed'. [157, Associated Press]

The states of Goa and Haryana, Jammu and Kashmir and the autonomous Ladakh Hill Development Council have instituted 'bans' on the use of plastic bags. The most systematic and publicised attempt to control the problem of plastic litter has been the actions taken by the hill station of Simla in Himachal Pradesh.

The Simla 'ban' on plastics

Simla, previously a retreat for the colonial British, is now a popular holiday venue for metropolitan Indian middle classes to escape the heat of the plains of the Punjab and Delhi. The population rises 100% in the hot summer months, and with it has come plastic rubbish – plastic bags, plastic bottles, plastic Uncle Chipps crisps packets etc. In 1995, the Himachal State department for Science Technology and Environment framed legislation to protect the Hill State from the rapidly increasing non-biodegradable waste. The legislation was passed by the government in July 1996 and was hailed as the first ban of its kind by any state government in India. The media was quick to respond and published stories in almost all national newspapers saying that plastics were banned in Simla.

But it was not a ban on the *use* of plastics. The legislation clearly stated that:

> 'No person, by himself or through another, shall, knowingly or otherwise, throw or cause to be thrown in any drain, ventilation shaft, pipe and fittings, connected with the private or public drainage works, any non-biodegradable garbage or any bio-degradable garbage in a non- biodegradable bag or container likely to:
>
> 1. Injure the drainage and sewage system.
>
> 2. Interfere with the free flow or affect the treatment and disposal of drain and sewage contents; and
>
> 3. Be dangerous or cause a nuisance or be prejudicial to public health.'

The ban was on throwing away plastics indiscriminately.

Even so, as news spread, the industry started feeling jittery. Virender Sharma, a senior scientist in the State Department for Science Technology and Environment and the person who framed the legislation, said that there was a tremendous pressure from the industry to use other words than saying 'plastics are banned'. The word ban would have an adverse effect on businesses. The ministry was unforthcoming about disclosing the means adopted by the industry to pressurise or mould the legislation. As a good gesture, Reliance, Sintex and IPCL, at a meeting held in Simla, offered to set up an advanced recycling unit in the state.

After several years, the Simla experiment appeared to have failed, but with lessons to learn. A failure as cheap plastic bags still littered the hill slopes, the Mall, and in open drains that carry the waste from the Mall to the lower side of Simla. According to Som Kirti, who heads a small group to create environmental consciousness, 'the government just imposed the ban without any idea how to go about it. [158, Kirti] [159, Rathore]

Ineffective planning was one of the reasons that the legislation was not an initial success. No new waste dumping receptors were initially made in the vicinity of the shopping arcades in Simla, although we now understand there are road-side bins marked for non-biodegradable wastes such as plastics. There was no attempt to monitor how effective the ban was. Not a single person was caught and fined – the legislation clearly mentions a punishment of one month in jail or a penalty of Rs5,000 if a person or a company is caught dumping non-biodegradable waste in public places.

Above all, no thought was given to provide an alternative for the cheap plastic bag. Dewan Chand Atma Ram, an expensive readymade garment store that started providing paper bags, was one minority example of a 'green' shop. [160, Ram]

There was an unforeseen problem of perception and education. The small dealers said that the customers asked specially for the polythene bags, sometimes even for an extra one. 'We are tradesmen and if the people prefer the plastic bags we have to keep them in mind to keep the shops running,' says Kishori Mal, owner of a general store in lower bazaar. [160, Ram]

However, despite this lack of initial success, there are state science department proposals for waste management in other towns in Himachal like Mandi, Kangra, Kullu and Manali.

Waste campaigns in Simla and Solan

The state science department started with a waste mapping of Simla. Prioritising on plastic waste, it imposed a 30% sales tax on plastic increasing the cost of a plastic bag from 10 to 13 paisas. At the same time it raised the price paid for plastic waste from Rs7 to Rs15 per kg. Green shops were identified. Lectures were organised in schools after which a lot of schools turned green by banning plastic bags. An NGO called Simla Amateur Garden Environment Society (SAGES) designed monkey proof dustbins. Project proposals were invited from urban local bodies, cantonment boards, educational institutions, mahila mandals, panchayats, NGOs, waste retrievers and interested individuals, for setting up recycling units.

In Solan, (60 kilometers from Simla), they have been effectively recycling for the past 6 years at the Jabli recycling plant. JSA, an NGO that has been doing work for waste management in HP, is producing school mats and several other items by weaving strips of polythene bags on looms.

The Goa 'ban' on plastics

In January 1998 the State of Goa also brought into force a similar act to Himachal Pradesh. One month after the act came into force 'none of the 30 villages and the two municipal councils of Margao and Cuncolim have taken any serious steps to implement it. Paucity of funds – many of the village panchayats are already cash starved – to purchase the dustbins and lack of suitable dumping sites are the main hurdles faced by the local bodies to implement the act', disclosed a cross section of the sarpanchas (village headperson). [162, Almeida] Goa has already ruled out recycling its plastic wastes. Dr N.P.S. Varde, Director and Joint Secretary at the Department of Science and Technology in the Government of Goa said, 'recycling may be viable in the big metropolis' such as Mumbai and Delhi but in rural Goa the commercial viability of plastics recycling is zero'. [163, Varde]

Goa is a wealthy state, with abundant natural resources such as fish and rice paddy, cash from mining and a flourishing tourist industry.

Tourists contribute large numbers of plastic mineral water bottles to join the ubiquitous plastic carry bags that litter beaches, roadsides and fields throughout the state. If Goa cannot control its plastic waste what hope is there for the poorer states like Bihar and Orissa?

Early in 1999, after The Goa Foundation took direct action, dumping a pile of plastic bottles at the gates of the leading water-bottler, Bisleri, the company agreed to put a deposit of Rs1 on some of its plastic water bottles. This is a step in the right direction – getting the manufacturer to take responsibility – but only a partial solution. Ideally, all should have access to clean water supplies, not only those who can afford bottled water. Fresh water supplies should be conserved and protected, so that no one needs to buy bottled water.

The Jammu and Kashmir 'ban' on plastics

In November 1998 the Jammu and Kashmir Government banned the use of plastic/polythene bags in Jammu and Srinagar cities in the public interest. 'A spokesman for the Government explained that plastic/polythene bags choke the drains and nallahs causing overflow and bad sanitation, besides, plastic bags if consumed by animals can even cause their death. The use of polythene bags has become an environmental hazard, as the material is not biodegradable. The use of plastic bags was discontinued in November 1998 and replaced by bags of alternative material (cloth and paper) which may be bio-degradable. [164, Hindustan Times] At the time of writing it is not known how effective this ban has been and whether plastic bags have disappeared from shops and streets.

Recycling – the industry solution

In India, there is reluctance to challenge the great gods of industry. 'Delhi's municipal authorities seem reluctant to impose a ban on the consumption of plastic, which they feel would amount to a trade barrier. Besides, there is the intense pressure from the industrial lobby,' says Ravi Agarwal of NGO Shrishti. [165, Indian Express] As we have seen, the Himachal Pradesh authorities were anxious not to reveal industry pressure and emphasise that they have *not banned* plastic bags. By not having a nation-wide ban or restrictions on plastic bags has meant that, to avoid higher taxation imposed in Himachal Pradesh, plastic bags are merely manufactured in Delhi and then transported to Himachal.

The problem of plastic waste is perceived as a problem for the community, the individual or government to solve by more effective waste collection rather than being the responsibility of the producer. When faced with a ban on carry bags by the Bombay Municipal Corporation, the Plastindia Foundation, through P P Kharas, argued that, 'spreading awareness to ensure people do not litter and that they segregate their garbage is a better approach to the problem. The segregated plastic can then be recycled. The government should facilitate a centralised approach to recycling rather than leave it scattered in various small-scale units. This will cut out the pollution caused by recycling plastic'. [150, Times of India] It is clear that the last thing the plastic industry is prepared to do is accept responsibility for the goods it manufacturers and profits from.

It is not in the interest of the plastic industry to promote recycling to the extent that it conserves resources, and decreases the amount of virgin plastic onto the market. Simple economic necessity demands that the sale of virgin plastics has to increase to pay back investment in petrochemical plant and processing operations. However, fearful of acquiring a bad image through the plastic bag scandal, industry mounted a public relations campaign to promote their commitment to recycling. A number of trade conferences and seminars have taken place since 1994 to examine ways and means of creating a recycling culture for plastics as part of an overall management policy for dealing with plastic wastes. In 1996 a National Plastics Waste Management Task Force (NPWMTF) was convened under the auspices of the Central Pollution Control Board (CPCB).

Plastics recycling

The purpose of material recycling is not only to deal with material wastes, but also to reduce the throughput of material resources, especially finite resources.

Recycling operations have been classified into four types by industry, the first two 'mechanical' and the second two involving incineration.

1. Primary recycling: Processing scrap plastics into the same or similar types of products as the original, using standard plastic processing methods. Primary recycling requires uniform uncontaminated plastics waste.

2. Secondary recycling: Reprocessing scrap plastics into plastic products that are not the same as, and usually inferior to, the original products. Secondary recycling uses a mixture of various plastics and non-plastics materials. This is the most common form of recycling in India.

3. Tertiary recycling: The recovery of chemicals from the waste plastic. For example, by pyrolysis and depolymerisation.

4. Quaternary recycling: The recovery of energy from the plastic wastes.

The latter two categories are essentially disposal options, favoured by industry because they avoid expensive separation and collection processes, but, above all, because they do not limit the through-put of virgin polymer into the market. They cannot be considered as true recycling, and are not common in India.

Problems with mechanical recycling

Unlike paper, glass and metals, plastics can rarely be truly recycled into the same product (primary) but are invariably 'down-cycled' to inferior products. As one engineer observed in conference, 'It is important to note that the plastics may be re-melted only a limited number of cycles before the material loses its structural value, at most twice. Therefore, the possibility of working 100% in a closed loop of reclamation is not a practical expectation'. [166, Zukermann]

Zukermann also notes that post consumer waste is usually contaminated which limits its economic viability. 'Generic plastic (one type of plastic) is expected to be quite pure in order to perform and therefore calls for extensive sorting, cleaning and removal of additives. This increases the cost of the reclaimed material to be almost as much as virgin plastic.'

The use of mixed plastics (in secondary recycling) to make plastic lumber (wood substitute) and related products presents different problems. 'Mixed plastics are usually chemically incompatible. In addition, the frequent changes in waste variety results in lack of control. In most cases the traditional plastic lumber is manufactured by low-end technologies. Therefore the end products are quite crude-looking, have inferior properties and are too expensive to be considered seriously as wood substitute.' [166, Zukermann]

PVC poses particular problems in waste streams intended for mechanical recycling. It cannot be mechanically recycled with other common commodity thermoplastics like PP and PE because of the difference in moulding temperatures. The moulding temperature of PVC is between 180 and 210 degrees centigrade whereas all the others (PE, PP and PS) can be processed together in the temperature range of 220 to 260 degrees centigrade. At these temperatures, PVC starts to decompose, forming hydrochloric acid (HCl), which is highly corrosive to equipment. By the same token, other plastics disrupt PVC recycling. This means that PVC, because it sabotages the potential recycling of other plastics, must be separated from mixed plastic wastes, such as packaging waste, before mechanical recycling. [167, Van der Naald] A particular problem with PVC is its incompatibility with PET. PET also has a higher temperature tolerance than PVC (250 degrees) and if the PET recyclate is contaminated with PVC it will leave black particles in an otherwise clean resin. As little as 20 parts per million – around one PVC bottle for every 50,000 PET bottles – can ruin a batch of recycled PET. [168, Plastic Engineer] The Association of Post-consumer Plastic Recyclers (APR) in the US publicly aired its concerns about recycling PVC: 'Post-consumer PVC bottles are a serious contaminant to the recycling of PET and HDPE.'

Therefore PET and PVC must be separated. PET and PVC cannot be separated using the flotation method, the most common method used in India, because they have similar densities. In the north special techniques have been developed to remove PVC in PET recycling, such as automated sorting based on colour, and detection of the chlorine atom in PVC via X-ray analysis. [168, Plastic Engineer] [169, Ehring] APR board member, Gary Pratt, described the financial implications:

> 'When you think about how much money it costs the industry to remove PVC, the financial impact is staggering. The capital costs invested in sensors (to detect PVC), the cost of testing to determine quality levels, and then the number of shipments from recyclers that are rejected because of PVC contamination – the whole plastics recycling industry would run more smoothly if PVC was not part of the post-consumer packaging waste stream.' [170, Association of Postconsumer Recyclers]

Recycling PVC costs more in Japan

In April 1998 Japan passed a new container and wrappings material law that required producers to recycle waste products. This prompted several major Japanese makers of household goods and cosmetics to switch from PVC to other plastics. 'The main reason is the cost. PVC must be separated from other plastics (because of the potential for dioxin formation) that are melted in a blast furnace before they are recycled.' [171, Pulse] Shiseido Company, Japan's leading cosmetic company decided to use polypropylene and other materials for all cosmetic containers by March 1999. Other Japanese manufacturers of cosmetics and common household products, such as Kao and Lion, are also phasing out use of PVC. Most convenience store chains, including Am/Pm Japan Co, Lawson Inc and Seven-Eleven Japan Co, have eliminated the use of PVC wrapping.

Greenpeace research found that PVC recycling in different regions of the world amounts to only about 0.1-0.6% of consumption. Its research showed that the PVC industry is supplying false information and even faking recycled products in an attempt to convince the public and decision makers that PVC can be, and is being, recycled. In Germany Greenpeace tested a so-called recycled window frame, promoted by industry as proof that old PVC windows are being recycled into new window frames. It was shown to contain no post-consumer recyclate – in fact it had merely been re-coloured to resemble a recycled window frame. Subsequent testing of other 'recycled' window frames showed this was the case for 8 out of 10 window frames. [167, Van der Naald] Independent research shows that by the year 2005 it will only be possible to mechanically recycle 15-30% of PVC consumed, and even then at a very high cost. Thus for 70-85% of PVC, waste recycling is not even an option for the mid to long-term. [167, Van der Naald]

Present evidence in the North, suggest that only PET and HDPE recyclate is of high enough standard to be used for recycling high quality products – so called primary recycling. The physical properties of re-compounded HDPE may be in the same range as virgin polymer. [172, Howell] Currently over 90% of mechanical plastic recycling, both primary and secondary, in Europe involves the polyolefins (PE, PP and PET). In the US, PET recycling has been the most successful of all plastics and because of this manufacturers are

substituting PET for other more problematic resins in a number of packaging products.

Chemical recycling

Chemical recycling means chemical recovery – recovering the various chemicals from the original material. It is claimed in India that the 'chemical technologies for the breakdown of such polymers (hydrolysis, glycolysis, methanolysis) are already proved, and are viewed as relatively cost effective'. [173, Srinivasan] But the evidence from the north, where these technologies have evolved, indicates otherwise. In the case of plastics many of the chemicals used in the original process are relatively cheap to produce and it is not clear whether the costs of recovering these chemicals is higher than the cost of virgin materials.

In chemical recycling the energy used in the original processing of the material is lost, therefore it is less efficient in terms of energy than mechanical recycling. Even in Germany, with high labour costs, chemical recycling is more expensive than mechanical recycling. [174; Pohle] German chemical giant, BASF spent DM40 million in the development of a pilot plant in Ludwigshafen based on but it called a halt to the entire project at the end of 1996.

PVC and chemical recycling

Once again, key technical problems arise with chemical and energy recovery technologies when PVC is an inevitable constituent of mixed plastic waste. Chemical recovery processes must take place at high temperatures, 500-900 degrees centigrade or more, or dioxin will form if PVC or other chlorine sources are present. [167, Van der Naald]

PVC again creates problems in chemical recovery because of the formation of hydrochloric acid, which is corrosive to machinery and harmful to the environment. Too much chlorine in the hydrocarbon end-product can pose a problem for refineries because hydrochloric acid may disrupt catalytic processes.

The main end-product of one chemical recovery technology, pyrolysis, is oil for the oil industry. 'It is questionable whether the pyrolysis of mixed plastics into oil can be marketed, partly because of the high chlorine content of the end product, uncertainties in the supply of mixed plastics and the high costs of the process.' [174, Pohle] The only pyrolysis plant that was being used was the Fuji-

Recycling pilot plant in Aioi, Japan, with a meagre capacity of 1,000 tonnes per annum. [167, Van der Naald]

Recovery for energy

In Europe[7], between 15-16% of plastics available for recycling (22-23% of all used plastics) is used as substitute fuel in waste-to-energy power generating plant, as plastic waste alone and together with Municipal Solid Waste (MSW). In some northern countries the recovery for energy is much higher, for example, Sweden turns 56% of its plastic waste into energy and Switzerland and Denmark 72% and 62%, respectively.

As with mechanical and chemical recycling, PVC once again creates problems. To limit corrosion of the heat recovery boiler from the HCl acid it produces, the steam pressure has to be kept low. Therefore, the average energy efficiency for municipal waste incineration is only 25% instead of 40% in a power plant. The main objective of burning plastic, therefore, is disposal and not the recovery of energy. Burning PVC creates additional problems, along with emissions of dioxin, for every 1kg or more of PVC burnt, 1.7 to 3kg of contaminated residual salts are created. [167, Van der Naald]

Plastic recycling in India

The management of plastic wastes in the north, and especially PVC waste, is very different from India's experience. In India the amount of plastic produced is still low per head of population, while recycling percentages are high. At present, fortunately, the plastic content of Indian Municipal Solid Waste is low compared to that of northern economies; an often-quoted figure is that plastics constitute about 4% of total MSW in India. The percentage of plastic wastes will inevitably rise as plastics consumption increases in India. Recovery, re-use and mechanical recycling levels are much higher in India for all plastic wastes – between 40% and 80%, depending on the commentator. Indeed, it has been stated that India has the highest rate of plastic recovery in the world. [175, Ratra].

[7] European overall recovery of plastics amounts to 22-23%. Approximately 7% is by mechanical recovery.

Two reasons account for this. One is that the 'throwaway' culture has yet to penetrate Indian society. Historically and today, materials, including plastics, are used over and over again, especially containers and bottles. Even broken plastic consumer articles like buckets, baskets, jerrycans, and car bumpers are reused. So-called 'plastic mechanics' visit various residential localities on weekdays and offer their services to repair on the spot broken plastics by the simple process of heat fusion. The other reason is that in India there is a wide-scale informal waste recovery sector based on a large number of human scavengers, known as ragpickers.

The economy of ragpicking

'This activity is born out of complete absence of options and a desperate need to survive in an overwhelmingly overcrowded labour market... A huge mass of extremely poor and destitute women, children and families who are totally dependent on waste picking for their livelihood, being illiterate, having no capital, collateral or skills to even run a small enterprise or survive by means of working for others.' [176, Krishna]

In sharp contrast to the documented life of a ragpicker, the Bhattacharya report acclaims the enterprise of ragpicking as being economically beneficial. The health risk is not mentioned.

> 'India has a well-developed working system for collection of plastic rejects and refuse from houses, garbage and junk heaps by ragpickers, who sell it to scrap dealers, often after segregation, based on the quality and grade of the material. The well segregated plastic waste then finds its way to the reprocessors.
>
> 'Unlike the developed world, mechanical recycling of reject/refuse plastic has developed as a major activity in India, virtually taking full care of the waste disposable problem, with economic benefit for a large number to boot.' [43, GOI Bhattacharya]

The numbers of people involved in collection are hard to quantify. O.P. Ratra estimates that 'over one million waste collectors/ ragpickers...are engaged in management of plastic waste in India. Most activity is concentrated in metropolitan centres, near to the source of valued wastes, the affluent urban middle-classes'.

Bare-handed scavengers

Ragpickers – 60% of whom are children, 30% women and only 10% men (mainly old and disabled) – pick waste using bare hands, from garbage bins and dumpsites by roadsides, or anywhere waste is thrown. 'Ragpickers have no access to protective gear or equipment. While picking material from garbage they routinely expose themselves to virtually the whole gamut of infections from hospitals and other medicare establishments beside handling toxic and hazardous substances from homes, shops, offices, small industries and service establishments... Many children, who start ragpicking at a very young age (some 5 and 6 years old, although most of them start between 8 and 11) succumb to infections and systematic disorders... All ragpickers are prone to numerous infections and infestations from coming into contact with garbage that contains animal and human excreta, sputum, dead animals and potentially infected hospital waste dumped into refuse dumps. These include 'sharps', i.e. scalpels and disposable needles that are indiscriminately dumped. Plastic disposables form a high proportion of medical waste and, having high resale value are much sought after by ragpickers.

Infections of the skin, respiratory tract and gastro-intestinal tract are reported to be more common among ragpickers than controls from the same socio-economic group. Also, rat bites, snake bites, dog bites and stings from vermin and insects. Cuts and bruises of the hands and feet by sharp objects in the refuse also occur frequently. [176, Krishna] These children are the short-lived, one-time disposables of our society.

The main plastic waste markets in India are in Jawalapur and Nand Nagri in Delhi, Johal Mohala in Bangalore, Dharavi in Mumbai, and in Calcutta and Chennai. According to Kisan Mehta, President of Save Bombay Committee, there are 150,000 ragpickers in Mumbai alone. If an average of 5 people were counted for each ragpickers family, then it would mean that 7 lakh (700,000) people in Mumbai survive on the collection of waste. The ragpickers earn about Rs1,500 to Rs2,000 (US$40-55) per month from the primary dealer.

Ragpickers contribute to Solid Waste Management 'by virtue of being one of the only and the largest recycling systems existing in the country. They provide huge labour, transportation and waste collection subsidies through their work'. [177, Chaturvedi] Yet there

is no formal recognition of this vital sector, and they have no voice. Bharati Chaturvedi, in her report, 'Public Waste, Private Enterprise', describes how, in some parts of the country, ragpicker's views are beginning to be taken into account through NGO waste projects, such as Mythri's 'Waste Wise Project' and 'Reds' in Bangalore. But these are isolated initiatives.

It is in the industries interest to support the ragpickers. 'Industry has even supplied bins specifically for plastics, giving the ragpicker a right to forage in a yellow bin. This and other industry projects remain piecemeal efforts, often misdirected and totally inadequate.' Chaturvedi recommends that the plastic industry invest resources to change the current ground level realities: 'To redirect waste from being disposed off without segregation. To stop it from being recycled in a hazardous way and move to a more equitable system of plastic waste management. Crucially, the informal sector, including ragpickers must be fully involved in determining the exact functioning of such systems, as they will continue to be, irreplaceably, involved. This, of course, should not be a stand-alone measure. It must be complemented by a good hard look at what plastics are doing to our environment and our lives.'

Government, in the shape of the Ministry of Chemicals and Fertilisers Working Group on Petrochemicals, glories in recycling's charitable employment potential:

> 'The increased usage of plastics has brought about social pressures among the developed nations and plastics have been termed as environment unfriendly. Legislation has been/are being enacted to curb wastage. The report highlights this area of concern and brings out that these notions are ill-conceived in the Indian context, as in India waste recycling very much forms part of the economic activity, providing gainful employment to the poorest section of society.' [43, GOI Bhattacharya]
>
> 'The customer today prefers purchasing goods from a shopkeeper who takes proper care of the goods by packing in plastic bags, separately and collectively. The used plastic is collected by ragpickers regularly earning their livelihood by this way. This industry has helped the Government in solving its employment

problems and has saved them from being converted into beggars.' [179, Bandhu]

But their heads are in the clouds – the plastic carry bag is not collected. Not even the lowly ragpicker is interested in picking through organic waste or trawling roadsides and fields to collect plastic carry bags. Although plastic fetches about Rs12 per kg in the waste market, it takes between 450 and 800 of these flimsy bags to weigh a kilogram and if they are soiled the price drops. This makes flimsy carry bags an extremely unattractive economic proposition for even the most destitute ragpicker.

Back street recycling

After being collected by ragpickers the waste is sold to dealers (kabadiwalas). Plastic waste is highly valued as we see from this March 1996 advertisement by a typical Delhi 'kabadiwala' described in Table 20.

This dealer has to sort out the waste according to plastic type. Separated plastic is sold to a medium dealer who in turn sells it to the secondary recycler at Rs15 to Rs30 per kg depending upon the plastic and its condition.

Table 20 Price of raw material (paper, glass, plastic for recycling

Old Newspapers English	Rs 5.00/Kg
Old Newspapers Hindi	Rs 4.00/Kg
Magazines	Rs 3.50/Kg
Loha/iron	Rs 5.50/Kg
Plastics waste (mixed)	Rs 12.00/Kg
Beer bottles (each)	Rs 2.00

Recycling of plastics is highly hazardous. 'Out of 750,000 people working in plastic units, only 10% are skilled personnel. The remaining 90% are semi-skilled or unskilled. Not only are they suffering due to the hazards of primitive ways of recycling but so are their unborn children.' [154, Yadav] Health, safety and environmental conditions in the primary recycling markets have, understandably, given rise to concern about workers and the surrounding environment, particularly in the aftermath of fires in plastic markets in Delhi, the largest centre of the Indian plastic waste trade.

Mohan recognises that the small-scale sector is particularly hazardous and difficult to regulate. Rather surprisingly, he recommends a more dependable power supply to aid their hazardous work, and the well-known end-of-pipe solution – the Common Effluent Treatment Plant:

> 'Plastic conversion has developed predominately in small-scale sector. Handling of PVC, ethylene oxide, toluene di-isocyanate etc pose problems of potential hazards. The situation is aggravated by undependable power supply in industrial estates. The Committee recommends that State infrastructure corporation ensure uninterrupted power supplies to these hazardous installations and should take new initiatives to build up common treatment systems for liquid effluents and a general safety and hazard control consciousness among the management and workers.' [9, GOI Mohan]

Delhi back-street Recycling

Recycling units often have the plastic waste sorted, cleaned and removed of foreign matter, in one room sheds crammed alongside the reprocessing equipment, the grinder blender, extruder, cutter, etc. In order to identify different plastics by density, flotation methods are employed, using water, salt water and mixtures of water and alcohol. Or, most often, simply by observation of resin type and product, such as transparent, white and coloured and whether milk, alcohol, hospital or just bottle. Regardless of contamination of the wastes, sorting is all done with bare hands.

Other methods are used to separate the non-plastic portion of wastes or different types of polymers fused together. 'For instance, the sorters separate cloth or 'rexene uppers from PVC shoe soles by turning them on open grates fired by cow-dung... Thus releasing fumes, potentially dioxin, into a small enclosed work environment.'

'The hygienic conditions of most reprocessing units is very poor. In many units the equipment is old and dirty and run down, and the wiring is unprotected... The levels of particulate matter in all units investigated is very high, i.e. above the standards prescribed in the Indian Factories Act, 1964. Reprocessing people are routinely exposed to the addition of toxic colours and additives used during processing.' [176, Krishna]

Problems with recycled plastic products

In a recently published report, Delhi researcher Krishna found that the machinery and method used to granulise the plastic has 'no temperature control or precautionary measures to prevent the plastic from degrading'. This makes the compounds and the products made from them suspect and unsafe, especially for reuse as packaging for food and beverages. [176, Krishna]

Many of the products made from recycled LDPE, HDPE, PP, PVC and PS, which have previously been used for storing toxic chemicals, paints, etc, are often washed and sold in the market to be reused as storage for water. Those that are processed and granulated are not segregated according to the contamination they have acquired during their first life span. The recycled plastic is then made into cheap products often for storing food, beverages and even healthcare products. The contaminants remain due to physical penetration of the toxic molecules into the plastics, and can easily leach out into food when substances such as water or fat are stored. [176, Krishna]

Most soft plastics will contain toxic additives such as lead and cadmium and soft PVC will contain phthalate softeners. Even polystyrene, the plastic most used for take-away food and one of the less environmentally damaging plastics has been found to contain toxic substances known to disrupt the reproductive functions of animals and humans. [180, Reuters] Impact resistant polystyrene was found to contain the highest amount of these substances. Recycled plastics will contain even more harmful substances than virgin material because if toxic substances are in source materials then they will be magnified in recycled products.

Senior governmental officials in the Indian Ministry of Environment and Forests (MOEF) are aware of problems with plastics recycling: 'The workers exposed to processing plastic wastes without protective clothing such as gloves, masks etc are visibly contaminated. One of the major problems in the processing of plastic wastes is the source of the wastes cannot be traced and it is very likely that these may include bottles and packaging from pesticides, cleansers and other toxic ingredients. In such cases it may lead to major health and environmental problems.' [181, Raghupathy]

Even O.P. Ratra, one of the plastic industry's most vociferous supporters, expressed reservations about recycled products: 'The

strength properties of recycled material do show up with finished product, as well as its unacceptable colour – which mostly presents a dirty look..... Recycled plastic products are economically priced, like PVC shoes, buckets, baskets, grocery bags, water bottles, suitcases, dolls and jerry cans, but the consumer is at a loss to determine their useful life, not to speak of their environmental receptivity vis-à-vis those made of virgin material.' [182, Ratra]

Enter the Plastics Task Force (NPWMTF)

Sparked by increased media pressure to address the problems of plastic litter, including haphazard medical waste disposal and the unregulated hazardous conditions in plastic waste markets, a 16 member National Plastics Waste Management Task Force (NPWMTF) was convened in May 1996 under the Ministry of Environment and Forests. Once again, this was a process dominated by industry. Of the Task Force members, 9 of the 16 were from the petrochemical industry, industry associations and an industry research institute. The rest were from the MOEF, The Ministry of Urban Affairs and Employment, The Department of Chemical and Petrochemicals plus the architect of the HP Non-Biodegradable (Control) Act (1995) and The Commissioner of the Municipal Corporation of Delhi. Dilip Biswas, Chairman of the Central Pollution Control Board, chaired the Task Force. [183, GOI] Its remit was to:

- 1. Formulate a strategy and prepare an action programme for managing plastics wastes.
- 2. Propose incentives and penalties to check the growth of plastic packaging wastes.
- 3. Prepare guidelines for the usage of plastic packaging.

Many of the measures recommended were an encouraging improvement given that no formal management regime previously existed. The Guideline on Plastics Packaging and Packaging Waste in India, published by the Task Force, emphasised the need to 'think about recycling, not when waste product accumulates, but right at the start of the development process'. This commendable recommendation would require consideration of the design of the product, not only its material life cycle but also the viability of disassembling its various polymers to simplify segregation.

The Guidelines 'aim to lay mandatory obligations on re-processors regarding working conditions'. These include: regular checks of working machines, especially temperature controls; monitoring of air quality and effluent; fire prevention measures; introduction of worker safety appliances such as gloves, masks etc and periodic health checks for workers.

Who will pay?

However, there is one blinding omission amongst these excellent recommendations: no reference was made as to how all these measures were to be paid for.

Improving the lot of ragpickers and reprocessing workers alone will cost many crores of rupees, but will this come from public funds or from industry? Article 15 of the Guidelines, 'Economic Instruments', is vague. 'Recycling, re-use and recovery offer a solution to reducing the volume of plastics wastes. These methods can be encouraged through incentives and penalties such as credits, taxes and other mandatory and voluntary restraints.....Assistance in developing the infrastructure needed for recycling of plastics packaging wastes shall be provided.' Government will help by 'preferential purchases of products such as dustbins, cable conduits etc, containing recyclate material, by public sector departments for use in their offices or projects'. And, in a measure indicating breathtaking ignorance of ecology, 'The use of products containing recyclates shall be further promoted by enforcing bans on use of resources that are *non replenishable/non eco-friendly such as wood etc*'.

The onus of responsibility for managing plastic wastes is placed very firmly on the shoulders of local authorities and the consumer.

> 'The primary responsibility of collecting, sorting and recovery of municipal solid wastes belongs to the local municipality or other relevant government authorities. To effect efficient collection, awareness regarding the proper disposal of waste has to be spread among the people. Due to the fact that plastics are used with customer comfort in view, it is also the responsibility of the consumer to ensure that the plastics products being used by them are recycled.'

Spreading this so-called 'dustbin culture' is all very well, but, as described earlier with the Simla and Goa waste management attempts, without resources to create infrastructures to collect, recycle and ultimately dispose of non-biodegradable plastics, any measures seem doomed to failure.

Development of effective waste management of plastics will be very costly, especially, as we have seen, with PVC in the waste stream. At present government revenues in India are mostly raised by customs and excise duties at entry and exit of goods to and from India. Systems of taxing householders for municipal services, common in the north, exist in India, but it is not clear what proportion is designated for waste collection. The amounts raised are certainly not adequate to deal with collection, transportation and disposal of wastes. Taxing the incomes of the middle classes and rich is bedevilled with avoidance and corruption.

Paying income tax in India

In his budget speech on June 1st 1998, Finance Minister, Yashwant Sinha announced that the total number of income tax assessors constitute less than 1.25% of the Indian population. (Assessors are those who are assessed for tax on the basis of returns they file.) In order to trace tax avoiders, the government is to target owners of cars, cellular phones and farmhouses on the assumption that if citizens can afford such luxuries then they are in a position to pay income tax. In a sardonic article, Outlook Magazine said, 'Who says Indians are tax dodgers? In the past two years, the number of income tax assessees has gone up from 1.4 crore to 1.95 crore. Still, to attain a globally comparable figure, the country needs another 2 crore assessees, phew!' In other words less than 20 million pay tax, but another 40 million ought to pay tax. [184, Outlook]

Therefore, it would be reasonable to expect the current beneficiaries of plastic consumption, the major polymer manufacturers such as IPCL and Reliance, to take a responsible role in upgrading collection systems, creating recycling facilities and improving the conditions of ragpickers and small-scale recycling operations. Indeed, this is the first broad objective of the Indian Centre for Plastics in the Environment, created alongside the National Plastics Waste Management Task Force process 'to encourage promotion and

upgradation of the Indian plastics production and plastics waste industry, both technologically and environmentally'.

One suspects that in reality its main objective is its aim 'to develop and sustain a respectable and environment friendly image of the plastics industry'. Government is expected to support the creation of this organisation with a 'one time grant. Annual expenditure of Rs3 crores (US$900,000) will be raised by the plastics industry. Staff and overheads will consume half leaving the remaining half (US$450,000) for 'promotion, publicity, awareness, publications, programmes, studies, surveys, travels, seminars, exhibitions etc'. In other words a colourful public relations jamboree and hardly an agenda or budget for revolutionising the management of plastics wastes in India.

An attempt at Take-Back

At the *first* meeting of the Plastics Task Force in 1996 it was mentioned that industry could introduce a 'buy back system as a pilot project in major cities'. The All India Plastics Manufacturers Association (AIPMA) was entrusted to take action on this issue.

Buy back, or a deposit/refund system, also called take-back, would be a simple and effective mechanism of dealing with plastic wastes. Take-back is a system that has existed for years in India with glass bottles. The price charged by the retailer for each bottle includes a deposit (usually Rs5) returned when the bottle is returned. Used bottles are collected, cleaned, disinfected, refilled with the same product and returned to the trading point. It is an effective circular system, using the same transport system for collection as delivery. The return to sender deposit on the bottle ensures it is 'valued', and therefore, even if the purchaser discards it, it will be collected by ragpickers.

In the case of plastics in India, take-back would help 'internalise' the real costs of petrochemical products into the price paid by the consumer, rather than plastic waste being part of the 'external' costs borne by the rest of society.

Take-back in Europe

With plastic products take-back is growing in importance in the north. In Denmark 37 producers of PVC profiles and windows voluntarily agreed in 1998 to take-back, without charge, post consumer PVC windows. In May 1998 the German Government approved a draft ordinance requiring the take-back of used telecommunications equipment and personal computers. Under the draft law local governments will be responsible for collection while producers will be required to arrange recycling, recovery or disposal of material. Consumers will be asked to pay fees for the take-back of products, thus, making these products more expensive.

By the *second* meeting of the Plastics Task Force, industry was clearly dragging its feet. The chairman, Dilip Biswas, enquired about the progress made for the launching of pilot projects. 'To this the representative of Plastindia mentioned that a detailed programme has to be formulated for which it is very essential that the Municipal Corporations have to identify areas that the industry can initiate such pilot projects in a year or so, and later on an understanding has to be given by the respective Corporations to take over the project.'

At the *third* meeting further institutions became involved in the deposit-refund scheme. 'A discussion regarding the Deposit-Refund scheme was held and it was felt that a concept paper may be prepared by Indian Institute of Packaging, Mumbai, in association with M/s Hindustan Lever and Proctor and Gamble Ltd.'

By the *fifth* meeting industry resistance was hardening. 'The proposal regarding shared-producer responsibility buy-back scheme in respect of Plastics Waste Management did not find much favour with the plastics industry during the discussion, since there was already a good network of waste dealers who are trading in plastic wastes. However, during the field visit, a suggestion was brought forward by the representative of the processing unit that there could be a voluntary scheme of the collection of PET bottles...back to the manufacturers and dealers of the respective products with suitable incentives offered to the consumers. This suggestion could further be enlarged and placed for consideration to the prominent manufacturers and packers.' From plastic take-back the discussion had been reduced to voluntary PET take-back.

At the *sixth* meeting, 'On behalf of Plastindia Foundation Shri S.K. Mathur presented an outline for a buy-back scheme to be adopted by PET bottles... During the discussion it was felt that the major users of PET bottles – Coca Cola, Pepsi Cola, packers of mineral waters and liquor, vegetable oils etc – should be involved in such a scheme right from the formulation of the project'.

Reading between the lines of the minutes, the *seventh* meeting was a heated affair. The PET bottlers, including the multinationals Pepsi and Coca-Cola twisted, wriggled and waffled their way out of taking responsibility. 'There is sufficient recycling facility for PET in India. The PET waste is low as against the recycling capacity.' 'Still PET has no value with the waste dealers in India'.

The Chairman, Dilip Biswas, then 'emphasised the need to introduce buy-back scheme for PET bottles/containers as well as other plastics waste'. The industry was forced to stop prevaricating. 'The representatives of the industry expressed their inability to launch a buy-back system for PET, in view of the fact that the consumption of PET in soft drinks is minimum. Whereas in respect of mineral water and liquor bottles, which are the major consumers of PET in India, such a system is not practical and viable.'

The *eighth and final* meeting of the Task Force took place in New Delhi, and on the same day (13th August 1997) a meeting of the newly formed PET Resin Manufacturers, Converters, Machine Manufacturers, Mould Makers and Recycling Machine Suppliers took place in Mumbai. Interestingly, it was convened by Reliance Industries. 'RIL, as a good corporate citizen, has taken the lead by co-ordinating the activities of formation of the PET association.'

It was emphasised that PET was being recycled in large quantities in India. The minutes of the meeting included a statement from a leading plastic processor, Mr Rangarajan, representing Futura Chemicals Ltd/ Indian Organic Chemical Ltd. 'Mr S. Rangarajan stated that the Ministry of Environment and Forests suggestion for buy-back of used PET bottles by beverage units is not practical, as, unlike in the west, mass consumption beverages in India are still packed in glass.'

Go to Goa, Mr Rangarajan, and see the lakhs of PET water bottles on the beaches. Here, as elsewhere, a take-back scheme could effectively resolve the growing mounds of plastic waste. (A potential buy-back/ take-back scheme is discussed later in Chapter 15)

One of the reasons that industry is reluctant to accept PET recycling was perhaps the fear that PET would be the thin end of a wedge. If they accept take-back for PET bottles, they might have to take on responsibility for other plastics, including such problem waste streams as PVC. As Mr Rangarajan said 'Singling out PET would only scare them away from using PET.' Dangerous indeed. The result of the take-back initiative was a total victory for industry intransigence. However, credit should be given to the Chairman Dilip Biswas who tried for a sound environmental option.

Industry is not prepared to countenance measures that would increase costs or reduce volume. Take-back policy could increase costs to the industry. The costs of recycled plastics in a regulated regime are probably higher than those of virgin materials. However in the long-term, take-back would provide a more level market place and encourage the manufacture of goods that are non-toxic, from sustainable sources that do not impose intractable wastes on the community.

Classification of plastics

On June 14th 1998, the CPCB announced that it was to introduce a colour code for plastic bags: 'The introduction of a colour code for plastic carry-bags to distinguish virgin plastics from the bags made of recycled plastic is an attempt to prevent food items being contaminated,' CPCB Chairman Dilip Biswas told The India Abroad News Service. 'The directives mainly aim at banning the use of recycled plastic bags for carrying edibles like meat, fish and cooked foods, which are likely to become contaminated by the plastic.' (MOEF September 1999)

This public announcement followed deliberations of the Task Force that included having the Indian Standards Institute set standards for 'the identification and classification of the recycled plastics material on the basis of its basic properties and application'. There is no mention of how these standards or government directives will be enforced. A survey by NGO, Vatavaran, estimated that there are 53,400 back-street recycling units in Delhi alone.

On December 23rd 1999, Congress introduced a bill into the assembly to ban the use of recycled bags but even its own MLAs opposed it. Speaking against the Bill, Congress MLA from Mangolpuri Raj Kumar said that the bureaucrats in the Capital had been misguiding people that the use of plastic bags was bad for

health. 'Because of this campaign, the Delhi Police have already started troubling the plastic dealers,' Mr Chauhan alleged. In an emotional appeal, Congress MLA Mr Gangwal said that the future of over 10 lakh people, who were working in the plastic factories, was dependent on this Bill. The Bill was 'shunted off' to a select committee thus further delaying implementation. [189, Hindustan Times]

The proposed solution: thicker and more plastics

In Bombay 1998, the June monsoon rains flooded King's Circle and other areas of the city. 'Millions of plastic bags' – jhablas as they are called by those most intimate with them, the ragpickers – were clogging the underground drainage system. The Bombay Municipal Corporation (BMC) responded within days, passing a resolution seeking a ban on plastics. Industry petitioned the Mayor Nandu Satam, and under this pressure he retracted the ban, arguing, 'Any decision taking in a hurry would adversely affect a large number of workers in the plastics industry'. [185, Jha]

At a public meeting, Dr Asad Rahmani, Director of BNHS (Bombay Natural History Society) said, 'The plastic industry, a fairly strong lobby, is trying hard to raise objections (to a ban). But I find their talk of putting people out of employment if the bag industry is sealed off, pure humbug. There are thousands who make a living out of drug peddling, but that does not mean that drug peddling should be allowed to continue and flourish'. [186, Indian Express]

The problem with plastic bags, the Mayor and industry argued, is that they are made of too poor a quality, they are too thin for the humble ragpicker to collect, so they are left to clog up the drains. The solution therefore arrived at by the Plastics Task Force was to ban the use of plastic bags that are less than 20 micron thick. They also banned the recycling of bags less than 25 microns thick.

Certainly the 'economics' of making thicker bags makes a sense. Bombay's ragpickers were interviewed for their reaction to this quality improvement. Yes, they ignored the thin plastic bags. 'A few years ago I had to stumble around for a whole day before I could collect a kilo of thin plastic bags which fetched only Rs1.50', said Mohammed Yunus, a Bombay ragpicker, who has since 'graduated' from plastic to collecting cloth and earning Rs150 a day. On the Dadar beach ragpicker Dattaram Kadam, still on the lower rung of

plastic scavenging, rummages though a rubbish tip with a stick. Thin plastic bags don't figure on his list, but the thicker milk pouches do. He washes the thick milk bags in the sea and dries them before selling them for as much as Rs20 per kg. 'Thicker bags are of great use to us,' he says. [188, Unnithan]

If this legislation ever becomes fully implemented throughout India the bags will no longer litter because once their weight is increased they become more attractive to ragpickers and recyclers. Removing the plastic carry bag from public view will solve the plastic industry's image problem. The throughput of virgin plastic will increase because more plastic will be required to make thicker bags. Thus it benefits the plastic industry. The central aim of recycling, to reduce the resource flow of virgin materials, seems to have been forgotten.

Part 3
The Age of Carbohydrates

11 Controlling hazardous industry

'Government clearly has a responsibility to ensure that adequate environmental and safety protection is taken by the (petrochemicals) industry through an apex body with wide representation from the industry, government and the scientific community.'

Government of India, Rakesh Mohan Experts Group Report on Petrochemicals, 1993

Petrochemicals is a hazardous industry and effectively controlling it is vital. A series of comprehensive measures is required: regulation of chemical usage in all production processes; protection of workers and the community adjacent to factories; accurate information for the consumer; and, finally, safe disposal of products at the end of their useful life. The stakes are high: the environment, and our health. There is a triangle of interested parties, all of whom are stakeholders and seek to influence the regulatory process: government, industry and the concerned public.

Governments are the traditional regulators of industry and its effects on resources, the environment, and human health. It is common in democracies that government operates through three counter balancing branches: the legislature, the executive and the judiciary. Through the process of democratic accountability, government representatives are expected to uphold and enforce the law and protect their citizens from environmental and other threats,

thereby balancing and offsetting vested interests and ensuring the long-term future of its citizens and their earth.

An effective regulatory regime to control industry is not yet in place in India. Government bodies created to protect the environment and human health are inadequately funded, fail to implement legislation, and blame each other for failure. Above all, they are subservient to the ministries that represent the interests of trade and industry. In the absence of a strong regulatory regime, industry has had a free rein to dominate the environmental decision making process. All major government decisions are mostly made in collusion with industry, and are taken in secrecy with no open discussion and limited sharing of information with concerned citizens.

It is left to those citizens most affected and concerned about hazardous processes and products to challenge. Their only avenue is the slow moving judiciary, mostly through Public Interest Litigations (PILs). In the case of environmental protection in India, the courts have been virtually acting as the executive with lawyers, acting on behalf of citizens' groups or individuals, petitioning the High and Supreme Courts to uphold the constitutional right of individuals to a clean environment. Not having an effective executive and leaving control to the courts brings dangers. Although sympathetic judges have helped to protect the environment and the rights of communities and individuals, their decisions are not always based on sound technical expertise. The World Bank has commented that 'the judiciary has been unable to deal with policy issues because it lacked the technical background needed to evaluate environmental impacts'. [190, Cambridge]

Indian environmental legislation

The Rakesh Mohan report noted that 'in India there is no specific legislation applicable to petrochemical industries alone'. This was confirmed in an interview with the Secretary of the Maharashtra Pollution Control Board, Mr Sanjeev Rao. According to him, there were 'no specifications or regulations regarding pollution in the plastic industry, whether polymer manufacturing or processing industry. Whatever regulations existed were available in the 'Red Book' published from New Delhi to which I could refer if I so wished'. [191, Ganesh]

The 'Red Book' is 'The Pollution Control Acts, Rules and Notifications listed thereunder,' published by the Central Pollution Control Board (CPCB). It contains government legislation regarding pollution of water, air and soil, procedures for dealing with chemical emergencies and regulations governing imports of toxic materials. The Red Book includes the Ministry of Environment and Forest's (MOEF) list of 18 polluting industrial sectors, which includes petrochemicals, listed in Table 21.

Table 21 Highly Polluting Industry Sectors

1. Aluminium smelters
2. Caustic soda units
3. Cement plants
4. Copper smelters
5. Dyes and intermediates manufacturers
6. Fermentation units
7. Fertilisers
8. Integrated iron and steel plants
9. Leather (tanneries)
10. Oil refineries
11. Pesticide manufacturers
12. Petrochemicals
13. Pulp and paper
14. Pharmaceuticals
15. Sugar
16. Sulphuric acid plants
17. Thermal power plants
18. Zinc smelters

Source: Ministry of Environment and Forests

The fact that a body of legislation exists, albeit a general one, provides industry with the perfect let-out when defending its environmental record. The chief spokesperson for the Confederation of Indian Industry (CII), K. P. Nyati, is content with the existing framework for control of pollution in India:

> 'There are nearly 200 statutes in the book of law that directly or indirectly deal or touch environmental protection...As regards effluent and emission standards, they are both general as well as industry specific. What is important to note here is that most of these standards are as strict as those imposed in US, Germany or elsewhere in the world...The water pollution standards are very comprehensive and cover almost all the

> pollution parameters right from BOD, COD, heavy metals to chlorinated toxics.'

Yet these 'comprehensive' standards do not include looking for complex and harmful chemical compounds such as dioxin, routinely generated by petrochemical plants. Generally, they are watered-down versions of those employed in the north.

Responsibility for protecting the environment and enforcing the existing legislation lies with the Ministry of Environment and Forests (MOEF). But by and large its influence has remained limited:

> 'Because of MOEF's relatively low power in the bureaucratic hierarchy, other ministries have little incentive to pay attention to the environmental consequences of their policies and the MOEF has not been able to influence other ministries.' [192, Khator]

The Central Pollution Control Board (CPCB), responsible to MOEF, is the body vested with power to implement the law:

> 'The Central Pollution Control Board is an autonomous body of the Ministry set up in September 1974, under the provisions of the Water (Prevention and Control of Pollution) Act, 1974. It co-ordinates the activities of the State Pollution Control Boards (SPCBs) and the Pollution Control Committees (PCCs). The CPCB, SPCBs and the PCCs are responsible for implementing the legislation relating to prevention and control of pollution; they also develop rules and regulations which describe the standards of emissions and effluents of air and water pollutants and noise level.' [193, MOEF]

According to a 1992 report of the Comptroller and Auditor General, the CPCB typically is *not* vested with the powers to discharge its responsibilities and has little if any control over the State Pollution Control Boards. For instance while it is supposed to co-ordinate and monitor their activities, the state boards neither consult the central authority when setting state norms nor are they obliged to comply with the standards which have been set by the CPCB. The CPCB cannot take over the activities of the state board if the latter defaults. The MOEF notifies standards in consultation with the state boards and not with the central authority.

> 'In fact the arrangements under the environmental policy created a double protection for governments – state governments could protect themselves by accusing the central government of failing to provide adequate funding, while the central government could pass the blame on to state governments for failing to implement laws.' [192, Khator]

Not only do they blame and protect each other. According to various sources, including a World Bank review of India's environmental situation, they are inadequately equipped and rarely enforce regulations:

> 'Although enforcement has improved significantly over the past several years in some of the more industrial States, the improvement is limited to non-toxic air and water pollution from large and medium-sized industrial units. Regulations for public units are poorly enforced due to political interference in the functions of the state boards. Most boards lack the capacity to monitor and enforce regulations related to hazardous waste management. As with other enforcement activities in India, corruption is pervasive.
>
> 'Although the increasing number of environmental laws require the (Central and State) boards to operate as environmental management agencies, their operating philosophies have changed little since the boards were established. Most of the boards have inadequate facilities and infrastructure. For example, while most of them have basic testing equipment at the central and state headquarters, this capacity is lacking at regional and local offices.' [190, Cambridge]

India's prevention policy

Currently India 'controls' pollution by setting limits to hazardous chemicals that can be discharged to air, water or soil and by defining the measurable quality of the receiving water or air. This setting of fixed quantitative and qualitative environmental standards was developed in the north. It is based on the belief that the environment possesses a certain assimilative capacity, a level of tolerance to hazardous inputs below which no harmful effects will

occur. However, in the north a vociferous environmental lobby is constantly challenging standards for emissions of particularly hazardous chemicals such as dioxins. Consequently the amounts of chemicals that are permitted to be discharged, that humans can be exposed to, are constantly under review. For example, the countries surrounding the European North Sea have agreed to reduce inputs of hazardous chemicals to zero or background levels 'within one generation'. In India discharge standards are not challenged.

Recently there has been talk of controlling hazardous industries, by preventing pollution, and promoting 'cleaner technologies' and products. Those involved in the environmental decision-making process, the Central Control Board, Ministries, industrialists, journalists, activists, are embracing a relatively new language when discussing methods of preventing pollution and with increasing frequency they are incorporating words and expressions such as Precautionary Principle, Polluters Pay and Clean(er) Production into environmental policy.

India's 1982 policy, for 'Abatement of Pollution', commendably moves towards pollution prevention and 'an overall policy objective to integrate environmental considerations into decision making at all levels'.

Unfortunately, preventative policies mostly only exist in theory. In practice, India is adopting so-called *end-of-pipe solutions* – placing filters, scrubbers, separators and purification plants at the end of emission pipelines or industrial processes. These are 'technological add-ons', often funded by aid from other countries or by World Bank loans. These technologies can be effective in reducing certain pollution problems, for example, recovering and recycling some metals or digesting nutrients, but there are fundamental and long-term drawbacks. They are further *added* processes, and adding technology will always involve cost, require further energy inputs and result in lowered energy outputs. More often these technologies only add environmental problems by transferring pollution from one medium to another.

A typical example is the Common Effluent Treatment Plant (CETP), proposed by Mohan to control emissions from petrochemical plants in his government planning report. The idea is to pipe all industrial effluent into one central treatment facility, which

is more cost effective than each industry maintaining its own treatment technology. This approach is usually planned for large industrial estates, for example, those in Gujarat at Ankleshwar, Vapi and Nandeseri that cater for small-scale operations. Many of the industries on these estates supply hazardous intermediate chemicals for the large-scale petrochemical sector.

Policy Statement for Abatement of Pollution

The Government of India issued a Policy Statement for Abatement of Pollution in February 1992. The policy statement affirms the government's intention to integrate environmental and economic aspects in development planning, with stress on the preventative aspects of pollution abatement and the promotion of technological inputs to reduce industrial pollutants. The overall policy objective is to integrate environmental considerations into decision-making at all levels.

Specific steps identified to meet this objective are:

- Prevent pollution at source
- Encourage, develop and apply the best available practicable solutions
- Ensure that the polluter pays for the pollution control arrangement
- Focus protection on heavily polluted areas
- Involve the public in decision making
- Increase the safety of industrial operations.

To achieve the objectives, maximum use will be made of a mix of instruments in the form of legislation and regulation, fiscal incentives, voluntary agreements, educational programs and information campaigns. The emphasis will be on increased use of regulations and an increase in the development and application of financial incentives. (Government of India, March 1992)

There are serious problems with most industrial waste treatment plants. Whether used, either at isolated industrial units or as CETPs, they are commonly designed to only address a very limited number of physical (pH, conductivity, suspended solids), biological (BOD, COD, coliform counts) and simple chemical parameters (nutrients, oil and grease, phenols, some heavy metals). This may address part of the problem relating to high loading of surface waters with

degradable organic material, but many components of the waste streams, most significantly the persistent organic compounds are simply overlooked. It is considered acceptable to discharge wastewater to surface waters, despite the fact that it may contain high concentrations of persistent organochlorine chemicals, for example. This was the case for two of the five treated effluent streams sampled by Greenpeace International at the Gujarat Industrial Development Corporation (GIDC) monitoring laboratory near Baroda. Di- and trichlorobenzenes were found to be particularly abundant and would otherwise have remained undetected. [134, Edwards] For industry to comply with existing legislation in India it is not required that either they or the pollution control boards fully characterise the chemical composition of effluent.

In addition CETPs are fundamentally incapable of degrading or detoxifying the wide range of heavy metal and persistent organic contaminants that are often present. At best they can achieve a redistribution of these contaminants from the liquid to the solid sludge phase. This reduces the immediate loading to surface waters but creates an additional contaminated waste stream that must be then disposed of.

Government Task Forces

When the media or the public expresses concern about an industrial activity the government is pressured to act. It adopts the role of mediator, often creating a specific committee or Task Force to examine the problem. Since the MOEF and CPCB occupy a low rung of power within the GOI, any environmental problem caused by industry has to be dealt with by consensus with industry. A Task Force is usually made up of technical experts from government and industry. They meet behind closed doors and reach agreement usually without any input from environmentalists or those affected by the problem.

One such Task Force was set up to investigate the environmental impact of chlorine, a highly dangerous chemical used widely in a number of industrial processes, including the manufacture of PVC plastic and in the pulp and paper industry. The Greenpeace report 'The Stranger', about the environmental impact of the chlorine industry, relied on over 100 scientific analyses for heavy metals and organic compounds in samples taken in India. 'The Stranger' report

was published in late November 1996. On January 10th 1997, the CPCB hastily created A National Task Group for Chlorine Use Optimisation in India.

As with GOI petrochemical planning committees, this Task Group was largely comprised of industry stakeholders with their paid academics plus a contingent of CPCB personnel. One woman, no health workers, no environmentalists, no representatives of communities exposed to the dioxin.

Its terms of reference included, somewhat radically:

> 'b) identification of areas requiring priority attention for minimising chlorine use and, c) identification of areas having possibilities of substituting chlorine use with other alternative chemicals.' [194, CPCB]

However, at a meeting on 7th February 1997 the Task Force (not surprisingly, considering the composition of the group) rapidly diluted its remit.

> 'It was agreed that the elimination of chlorine is not desirable in the country. The members recommended that the overall objective of the Task Group should therefore be shifted from minimisation of chlorine or its compounds, *to minimisation of the environmental implications resulting from the use of chlorine and its compounds*'.

At the 2nd Task Group meeting in February 1997, The Plastindia Foundation contingent (a public relations body of the plastic industry in India) presented a series of well-rehearsed platitudes on the essential role of PVC to the Indian economy. It stressed that the plastic industry involves relatively fewer hazards to the environment in the form of emissions/discharges, compared to the Pulp and Paper industry. A difficult statement to prove when neither industry in India has produced, or has access to, any quantified or qualitative data on their emissions of hazardous chemicals.

The National Plastics Waste Management Task Force (NPWMTF), already mentioned in connection with recycling had a similar cosy relationship with industry. The majority of its members were from the petrochemical industry, the rest from Government; none were from the public, concerned about the propagation of plastic wastes. Attempts to introduce a producer responsibility for plastic products

(product take-back) were transparently thwarted by the industrial lobby, led once again by the Plastindia Foundation.

Any agreement reached within these task forces is clearly based on what industry will accept rather than what the situation demands. As we shall see, industry is able to make claims based on unsubstantiated opinion rather than accurate science. Within the closed process of committees and task forces their claims go unchallenged. There is no independent regulatory regulation authority in India, such as an environmental protection agency, to check and balance the interests of industry and protect the interests of the environment and its people.

Industry's self regulation – Responsible Care

Governments world-wide, including India, are encouraging industry to self-regulate. The cost of evaluating the health risks from a growing number of chemicals in commercial use has become an expensive burden for governments. 'Every year, 1,000 new chemicals enter commercial markets in the US; meanwhile the National Toxicology Program, the agency responsible for assuring the safety of these chemicals, can only manage to conduct testing on 25 of them annually.' [47, Clarke] In a global political climate dominated by 'free-trade' and open markets, industry and the multi-nationals, in particular, are being allowed to police the environmental and human health impact of their own operations as well as set the political and economic agenda. Governments are often prepared to accept industry's self-regulating regimes without independent scrutiny.

Two international self-regulatory organisations dominate – a general industry body, ISO 14001, and a chemical industry regime, 'Responsible Care'.

ISO 14001 grew out of the World Trade Organisation (WTO) agreements on world trade. It has become an international standard for continuous improvement of environmental performance. By this standard companies can set their own criteria areas for measuring environmental improvement, and frequently do. This could mean anything from planting an increasing number of trees around a hazardous process plant to publishing a Toxics Release Inventory. The standard does not require evaluation of the environmental impact of processes, production methods or even the products themselves.

In the wake of the Exxon Valdez oil spillage in 1989, the chemical industry evolved it own environmental club, named by their public relations departments, 'Responsible Care'. The concept originated in Canada and was then adopted by the US and the UK. Its membership has spread to South and South East Asia, and includes India's Reliance Industries.

Under 'Responsible Care' individual chemical companies voluntarily demonstrate their commitment to improve all aspects of performance, which relate to the protection of health, safety and the environment. Rakesh Mohan, believes that such programmes will help clean-up the industry.

> 'It has been often stated that petrochemicals are not environment friendly and that they may pollute the atmosphere. This misconception has probably come about due to past policies wherein downstream units manufactured hazardous chemicals with capacities far below economic norm and sometimes under the aegis of small-scale industry which did not have the technology for either prevention or treatment of pollutants. Adequate economic size coupled with awareness towards Responsible Care can lead to an almost zero level of pollution over a period of time.' [9, GOI Mohan]

Only through economies of scale and industry self-regulation can near zero level of pollution be achieved. In other words by allowing the 'poachers' to act as 'gamekeepers'. This is nonsense. The petrochemicals industry has never been able to achieve zero pollution even in highly regulated industrialised countries. As long as toxic substances are created and used they have to be disposed of. It makes no difference how 'clean' the technology and treatment facilities are – landfills leak, fresh and marine waters cannot dissolve persistent chemicals. Even the most efficient incinerators will create toxic ash that needs to be landfilled.

Reliance became a signatory to the Indian 'Responsible Care' programme on its inception in India in 1993. Reliance, 'has sought to consistently prove its environment care practices to absorb new advances in technology. As a result, the company has been able to keep its effluent discharge and process water consumption far below

the statutory limits, and has consistently improved upon these levels year after year. Reliance has sought to continuously reduce the pollutant load on the environment by controlling the quantity of pollutants at source, adopting more environment friendly processes and by recycling streams that yield organic pollutants'. [60, Reliance Industries]

Yet Reliance does not make public information on what pollutants it creates or how they are ultimately disposed of, whether they are discharged into the air, water or in the form of solid waste. Certainly its PVC production must produce dioxins. We do not know the technical details of its process waste incinerators or how and where residues are landfilled. Its plants may be run to the same standard as 'state-of-the-art' petrochemical plants in the north, but even northern industry is not considered to be zero 'clean' and is under pressure from local citizens' groups and regulators, especially in the US.

We know from evidence in the north that programmes such as Responsible Care are more often than not part of a chemical company's public relation exercises – designed to improve the industry's image. Such programmes co-opt the language of environmentalism but carefully do not define criteria or state clear goals. They mention pollution prevention and reduction, though not phase-out or bans. Implementation of management practices is not subject to third party verification. In principle, they want to create safe products yet there are no criteria for what constitutes a safe product.

Above all Responsible Care is a means of avoiding command and control regulation, in particular public disclosure of full information about the usage and emissions of chemicals. As Bill Walsh of Greenpeace USA said to Chemical Week magazine in 1991, 'Responsible Care is like the drug pusher giving people clean needles. It does nothing to wean people from a destructive habit. It just makes them feel comfortable about a practice that is inherently bad for the environment.'

12 Claim and counterclaim

'The language used is always that we are 'killing' the industry. Let me tell you I don't see any corpses.'

Emma Bonino, EU Consumer Affairs Commissioner, 1998

As the speed of 'development' has increased in the post-liberalisation period so has the degree of opposition to those developments, and India is ripe with environmental protests. Amulya K.N. Reddy describes the process of conflict in India.

> 'Firstly the government in its role as developer comes up with a major project to supply infrastructure inputs. In the process they forget, or ignore, or suppress crucial side effects and environmental impacts. Socially conscious citizens, independent experts and civil groups then highlight the negative aspects of the project. Soon a major battle develops. On the one side, there are environmental agitations, public interest litigations and political movements opposing the project. And on the other side are the interested politicians, the government agencies, and the industrial-commercial/contractor lobbies pushing for the project. What differs from one project to the other is only the intensity and outcome of this conflict.' [195, Reddy]

Public concern about industrial development in India has focused less on the problems of health effects of chemicals (perhaps in the

absence of information about the types of chemicals being produced and discharged to the environment) than the social and cultural impact. A typical example is the reaction to the plastic bag – seen as an 'irritant', a drain clogger, rather than a potentially toxic problem. Planned large developments, whether industrial or for infrastructure (dams, ports, roads and transport projects) have been fought by civic groups and environmentalists largely because they would expropriate lands used for traditional activities and displace those living there. The threat of polluting water and land is perceived as a secondary factor. The complexity of plastic chemistry and its environmental impact appears to be little known or understood.

With the government protecting trade interest and promoting economic growth, colluding so closely with industry, the affected and environmental protectors are consequently marginalised and attacked as being against development and modernisation. They are not only in conflict with industry and developers, but are often accused by both government and industry of being virtual enemies of the state.

Defence and denial

In the absence of a strong regulatory voice, Indian industry does not even have to attempt a scientific justification. It can simply deny that a problem exists. Responding to a summary of the chemical hazards posed by the PVC industry published in Greenpeace's, 'The Stranger', the Plastindia Foundation replied.

> 'Production of PVC is extremely safe and substances like VCM and EDC are handled with complete safety during PVC production. The latest closed-loop systems are completely safe and closely monitored by environmental protection agencies the world over.' [136, Hindustan Times]

When science is invoked by industry it is sometimes inaccurate, and obviously favours the commissioner. The Plastindia Foundation briefed the Chlorine Use Task Force meeting on the formation of dioxins:

> '.... there are nearly 212 dioxins that can be formed, and only two of these are reported to be harmful. It has stressed that formation of dioxins requires specific

> temperature conditions. In other words, emissions of dioxins can be controlled by proper operations of the incinerators.'

The Plastindia foundation is being 'economical' with the facts. The US EPA recognises 210 (not 212 quoted above) individual 'dioxin' congeners, 75 of which are polychlorinated dibenzodioxins (CDDs), and the remaining 135, polychlorinated dibenzofurans (CDFs). Of these, 2,3,7,8-tetrachloro dibenzodioxin (2378-TCDD) is considered to be the most toxic, but is by no means the only toxic congener. Indeed 7 of the CDDs and 10 of the CDFs showing 2,3,7,8-chlorine substitution are considered to show dioxin-like toxicity, albeit to different degrees. [196, Santillo] Therefore there are 17 congeners that can be harmful rather than the 2 mentioned above. Many other compounds, which may frequently be found alongside dioxins, exhibit dioxin-like toxicity. This includes a number of polychlorinated biphenyls (PCBs) and polybrominated compounds. Of the 209 PCB congeners, for example, the 13 co-planar PCBs are also assigned dioxin toxicity equivalence factors. [196, Santillo]

There are indeed highly sophisticated and hugely expensive incinerators (commonly built in the north) dedicated to specific hazardous waste streams that can reduce dioxin formation to barely detectable levels. Yet even in these cases monitoring is limited and might amount to a test done twice a year, or even less. And while sophisticated high-temperature incinerators can limit air emissions of dioxin, they can also concentrate dioxins into ash, which is then land filled and not destroyed.

Most dioxins arise from smaller scale municipal waste incinerators, medical waste incinerators and from uncontrolled sources of burning chlorine including PVC cabling, scrap, wastes and products. These major sources of dioxin can never be realistically controlled, except by eliminating the chlorine donor, which so often is PVC plastic.

Questions of the toxicity of plastics and their potential threat to human health did not feature on the agenda of the Plastics Task Force. It is interesting to note that the sole external sources of information annexed in the NPWMTF Guidelines are promotional materials from of industry plastics associations in Japan, UK, Europe, Canada, the US and Malaysia. There is no reference to concerns

being voiced by environmental agencies such as the US EPA about the toxicity of certain plastics, particularly about additives. No reference is made to how the Netherlands is limiting the growth of non-biodegradable plastics or to Sweden, Denmark and other countries that have placed restrictions on the use of phthalates and other toxic additives in PVC.

A favoured ploy when attacked, is to invoke the spectre of foreign conspiracy:

> 'Plastindia Foundation feels these reports[8] are mischievous and motivated to disturb the Indian industry which has after many years has woken up and starting expanding. Such mischievous reports which pretend to be on scientific basis and conveniently ignore the other scientific data available, seem to be aiming at curbing the growth of Indian industry so that it should remain import dependent.' [136, Hindustan Times]

These remarks are untrue. The Greenpeace science was of an international standard – there was no pretence about it. The purpose of the report was not to be mischievous, but rather to bring the facts about the environmental impact of a particular industrial sector into the open. Making India import dependent is not the goal of such reports, rather the contrary – the report affirmed the need for India to make its own decisions, based upon its own data. The fact that the CPCB hastily convened a task force to examine the chlorine industry soon after the publication of 'The Stranger' showed that government scientists and technical experts found the report's findings merited serious consideration.

The other 'conveniently ignored' scientific data referred to by the Plastindia Foundation is certainly not from Indian sources, and is probably provided by the global petrochemical club. This means the Vinyl Institute (VI) in the US, The British Plastics Federation (BPF) in the UK and the Association of Plastic Manufacturers in Europe (APME), along with a myriad of other bodies well funded by industry to defend or evaluate the environmental and health performance of their processes and products. In order to set their own agenda, these organisations commission their own scientific

[8] The Plastindia Foundation is referring to Greenpeaces' publication 'The Stranger'.

research. Science studies paid for by industry are invariably skewed to favour the client. As one would expect, evidence of these practices is often hard to find. However, when the science of the northern petrochemical industry is exposed as flawed, Indian industry spokespersons, who unquestioningly use the same studies, will share the same embarrassment. The Rigo study commissioned by the US Vinyl Institute is a typical example.

The Rigo report and the plastic clubs

The Vinyl Institute (VI) commissions so-called independent scientists and otherwise reputable bodies to produce reports and studies that defends PVC on public health and environmental grounds. The conclusions of one such study, by the American Society of Mechanical Engineers (ASME), authored by Greg Rigo, purported to show that there was no correlation between chlorine content and dioxin emissions from combustion processes. [197, Rigo] This Rigo study has been liberally quoted in India, in lectures and at conferences.

- In the First IPI Chemplast Endowment Lecture, N.M. Dhuldova stated: 'A study has concluded that there is no relationship between the chlorine content of wastes and dioxin emissions from combustor process.' [66, Dhuldhoya]

- At the National Conference on Plastics and Environment held in New Delhi September 1996, the Rigo study was quoted directly: 'The American Society of Mechanical Engineers (ASME) has concluded in a recent study that there is no correlation between the amount and type of chlorine in the waste stream and the amount of dioxin emitted by waste incinerators.' [198, Bandopadhyay]

- The same wording is used again by the same author at the National Seminar on Recycling and Plastics Waste Management held in September 1997. [199, Bandopadhyay]

The scientific methods used by Rigo, and his conclusions, have since been questioned and challenged. Greenpeace Research Laboratories reviewed the Rigo study for two reasons: 1) the conclusions point in a different direction than most other published technical literature on the topic; 2) primary funding (US$150, 000) for the study was provided by the Vinyl Institute (VI), a trade association representing corporations that manufacture PVC and its chemical feedstocks.

Greenpeace concluded in its review of the Rigo paper:

> 'Our review shows that a surprisingly higher degree of correlation exists between chlorine input and dioxin stack emissions than is concluded by the ASME report. Over and above these discrepancies, the data and methodologies are inappropriate and/or unreliable for assessing the relationship between chlorine inputs and dioxin outputs from incinerators.' [200, Costner]

A report in the prestigious international science journal, New Scientist, [201, MacKenzie] quoted two senior scientists in the US who supported the Greenpeace review. Valerie Thomas of Princeton University, in her own study in 1995, came to an opposite conclusion to Rigo, and found a significant correlation between dioxin output and the input of chlorine. Ellen Silbergeld of the University of Maryland, who sits on the EPA's dioxin advisory panel, also supported the Greenpeace analysis. She said that it is 'appalling that the ASME was not more critical' of the Rigo report before endorsing it.

Uproar at the Dioxin conference

Greenpeace's review caused uproar at the normally sober annual International Dioxin Conference held in Indianapolis US in August 1997. After Greenpeace scientist, Pat Costner completed her 15-minute presentation two men rushed to the microphone. One was Greg Rigo, author of the ASME publication. Red-faced and sweating profusely, he contended rather heatedly that Costner had misconstrued his findings. Costner replied that she had simply used the statistical values he had presented in his report. Dr Vikelsoe from Denmark offered public support for Costner's analysis by describing Danish studies that found chlorine input and dioxin emissions to correlate positively. Rigo again took the microphone. As the volume of the exchange between Rigo and Costner increased, with Rigo almost shouting interruptions over Costner's reply, the chairperson was forced to close the session.

The background story to the Rigo study, described in Annex 1, illustrates that the chemical industry is ruthless when defending its products and will go to considerable lengths to protect its interests globally. Lest we forget, the expansion of the plastics market in India not only benefits Indian companies, but also their foreign partners selling technology and engineering to new petrochemical projects in India.

Lobby power

Apart from creating or manipulating science, industry uses every political process it can to defend its processes and products. Recent concern about the use of phthalates in toys was an obvious threat to the polymer, and PVC industry in particular. Behind the scenes industry fought the threat of a Europe-wide ban. The ban could potentially cause an enormous loss of trade in toy sales for US Mattel and others, especially as the scandal arose just before the vital Christmas sales season. Mattel's global sales of infant and pre-school toys reached 1.8 billion dollars in the previous year, 1997. Mattel lobbied the US Government to 'put pressure' on Europe. However, the extent to which the industry in the US used its political connections to pressure the EU became public to the embarrassment of the Clinton administration. Early in 1999 the Clinton adminstration was compelled to issued a letter, signed by Vice President Al Gore, to 28 members of the US Senate.

> 'I have made it clear that the Departments of Commerce and State should refrain from any actions to discourage individual countries, whether in the European Union or elsewhere, from implementing precautionary measures they deem appropriate to restrict the marketing or use of products containing phthalate(s).' [202, Greenbase]

As well as intensive lobbying, industry recruits scientists and consultants that favour its view. In this case the 'world's leading scientific management consultancy', the Weinberg Group. This group issued a press statement on June 16th 1997 stating that 'There is no evidence to justify proposals by the European Commission to ban the sale of phthalate containing PVC toys'. The Weinberg Group is a consultancy that acts for clients, according to their own advertisement, 'to support and promote continued use of substances and preparations under public, media, legislative and/or regulatory attack'.

How the PVC industry fights

Faced by a possible ban by the EU on the sale of PVC toys containing phthalate plasticisers, US chemical and toy companies enlisted the aid of the Clinton administration. A.Vernon Weaver, the US Ambassador to the European Union, warned the EU 'the sudden ban, on incomplete and perhaps erroneous information, could cause trade misunderstandings between the United States and the European Union'.

Greenpeace obtained documents through a Freedom of Information Act Request in the US that showed the cosy relationship between the US Government and toy manufacturers. These diplomatic cables from the US State and Commerce Departments laid out in detail how Exxon, which makes phthalates, and Mattel, the world's biggest toy manufacturer, were able to get American diplomats across Europe to go to work against the proposed ban. One cable sent from Washington was explicit: 'The ban could result in an enormous loss of trade in toy sales for Mattel and others and should be blocked in time for the Christmas purchasing season.'

EU Consumer Affairs Commissioner, Emma Bonino criticised industry groups for supplying her with exaggerated and incomplete information on the effects of a possible ban on the phthalates in plastics. Speaking at a conference in Brussels on the subject of 'pressure politics', Ms Bonino said industry failed to give a clear and honest picture of what effect a ban on phthalates in some children's toys would have. Accusing industry of exaggeration, she said: 'the language used is always that we are 'killing' the industry. Let me tell you I don't see any corpses'. [203, ENDS]

Protecting vested interests

Industry has enormous amounts of resources with which to promote its interests with government and the public, including advertising, expert public relation departments and skilled lobbyists. It often wants to change perceptions rather than confront facts, avoiding what Public Relations Company Burson-Marsteller called 'the killing fields', the facts of environmental and human health risk.

Symbols instead of facts

Burson-Marsteller, the world's largest public relations company, were hired by EuropaBio, Europe's largest bio-technology federation, to change public perception of genetically engineered crops – an issue of great concern to farmers in India. Greenpeace was leaked a copy of their strategy document prior to the first European Bio-industry Conference in June 1997. Burson-Marsteller advised the federation to steer clear of any form of public debate and particularly the industry's 'killing fields' – namely 'public issues of environmental and human health risk'. Instead the industry should concentrate on the spread of positive stories and symbols, eliciting a message of 'hope, satisfaction, caring and self-esteem'. Symbols, they add, 'are central to politics because they connect to emotions, not logic'. [204, Labes]

Politicians can be bought, secretly or with positions within a company. This is a world-wide phenomenon, certainly not restricted to India. When threatened, industry uses its financial and political strength to defend its products and processes. As we have described, in the absence of a strong regulatory regime, it may deny a problem exists, bring in the foreign conspiracy demon, use science selectively, or even buy scientists to create its own science.

Government in the north, through strict enforcement, has sought to limit the hazardous consequences of industrial development. It has accepted the need for industrial development and its products and seeks only to control the negative impacts of its processes. Whereas in India, where regulation and enforcement remains inadequate, the very *need* for such industrial processes and products is questioned, most often by those whose lands are being expropriated in the name of 'development'.

Reddy suggests that the environment/development conflicts can be minimised and possibly avoided by adopting a more consensual, democratic process.

> 'What is required is the implementation of a new agenda based on a quantitative statement of what the project intends to achieve, a comprehensive listing of all possible options for achieving the objective, rigorous comprehensive (real) costing of options, inclusive of externalities (costing environmental degradation, public health bills, rehabilitation of displaced persons etc),

> determination of a least-cost mix of options, clear explicit description of the distribution of benefits according to region, location, income group and gender, environmental impact assessment, universally accessible information and transparency, democratic participation and decision-making along with the necessary institutional changes.' [195, Reddy]

These suggestions are steps in the right direction. However they do not answer some more fundamental questions. Who sets the agenda in the first place? Certainly with the present construct, the locally effected community is not involved in the initial decision-making process at all. Industry and its like-minded allies in the government bureaucracy formulate development plans behind closed doors.

Secondly, can a true costing be made of externalities, including the loss of traditional lands and sustainable livelihoods? Does 'a quantitative statement of what the project intends to achieve' include addressing the real needs of the affected community or India generally? Some development projects will not only impact the immediate locality but will have wider socio-economic implications, such as the replacement of one material, jute, with another material, polypropylene. Petrochemical developments will impact the locality through loss of land, the health of workers and the discharge of toxic chemicals as well as threaten traditional industries. The impact of its products, often toxic and certainly not bio-degradable, will be felt wherever they are marketed in India, by which stage they are beyond the control and responsibility of the manufacturer.

13 Life Cycle Assessment

'Plastics are more environmentally friendly as they consume less energy (in producing, processing and use) than competing commodity materials.'

Government of India, Bhattacharya, 1993

Supposedly, one way to settle the debate about whether any material is harmful or safe is to draw together all available evidence into a comprehensive *Life Cycle Assessment*. This evaluates the positive and negative aspects of a material's production, use and disposal. Decisions can then be made to favour one material over another, or ways can be seen to improve the negative aspects of a particular material. *Risk Assessment* is another measurement tool used. These methodologies have value, but both are seriously flawed. In particular neither can be used to effectively evaluate the social and cultural impact of production systems.

Risk Assessment tries to reduce to numerical values all the complex factors of a hazardous procedure, for example, to arrive at the one in million statistical chance of incurring a cancer from exposure to a particular chemical. Risk Assessment usually focuses on one chemical at a time, often ignoring the fact that human health problems arising from chemical exposure can be the result of exposure to many different chemicals. The process does not normally take into account sensitive populations such as children, the elderly, and the chronically ill. Risk Assessment attempts to calculate in monetary terms the value of human life, where life is often judged to have less value in the south, since earnings are lower. The more

data that is available or collected gives Risk Assessment studies greater value when used by decision-makers. For these reasons it remains an improvised science that processes data of unequal quality and turns statistical analyses into dubious predictions.

Life as a number

Industry, government, regulatory bodies (including Multi-National Development Banks) employ companies and consultants to evaluate the environmental and human health impact of chemicals, industrial processes and products. The process known as Life Cycle Assessment (LCA) attempts to formalise the evaluation of the environmental impact of a process or product in a prescriptive, quantitative manner. It appears to arrive at an entirely objective assessment despite the considerable subjectivities, uncertainties and indeterminacies that prevail. The analysis attempts to take into account the entire life cycle of the product covering all the processes required: extraction of raw materials, manufacture, transport and distribution, use, reuse and maintenance, recycling and final disposal. It is a survey of all resource and energy inputs and all the emissions and waste outputs. [105, Hendriks] The criteria used in our pyramid of plastics hazards, Table 20, has been done on the basis of placing the most common plastics in order of the 'environmental and human health impact' of chemicals involved in their manufacture, use and disposal. Other criteria could be used when comparing plastics to each other or to other materials in terms of their environmental performance.

Life Cycle Analysis: how does it work?

LCA is normally made in three stages:

1. Inventory: Identifying and quantifying the environmental loads involved, the energy and raw materials used, and the emissions and waste consequentially released.

2. Impact assessment and evaluation: assessing and evaluating the potential environmental impact of these loads.

3. Recommendations for improvement: assessing the opportunities available to bring about environmental improvements.

LCA is gaining importance, especially in the north, as a tool for decision making. It is increasingly being used for the improvement of both products and processes, in setting criteria for eco-labelling

and for decision making generally. But it is most commonly used to compare products in terms of overall environmental impact. Sophisticated computer modelling techniques have been evolved to reduce complex factors to quantifiable data. It is employed in the Indian government petrochemical planning reports to show that plastics are environmentally sound.

Problems with LCA judgements

However, LCAs are based on a myriad of assumptions, which differ depending on who conducts the analysis, although there are some standard guidelines. Plastic producers conducting LCAs usually assess their own materials favourably, as the Norwegian multi-national Norsk Hydro did when conducting an LCA of various applications of PVC. And, not surprisingly, it works the other way round. In the International Jute Organisation's (IJO) LCA of jute versus polypropylene 'jute can be classified as more environmentally friendly than polypropylene'. [105, Hendriks]

LCA Clay pipes versus PVC Pipes

A 1996 LCA published by the Dutch association of concrete pipe manufacturers, VPB, concluded that concrete sewer pipes have a markedly better environmental performance than PVC pipes across a range of impacts. [205, ENDS]

Previously, in 1992 Norwegian PVC manufacturer Norsk Hydro conducted a survey of LCAs of PVC in various applications, including pipes, and concluded that it is 'difficult to find a scientific basis to label PVC as environmentally less preferable than other materials', and decided that no firm conclusions could be drawn.

In 1995 the Dutch association of plastic pipe manufacturers (FKS) carried out an LCA comparing PVC, concrete and clay sewer pipes. FKS concluded that recycled PVC was the best in terms of energy consumption, air pollution and solid waste generation, while clay and concrete were better on water pollution and resource depletion.

Because LCAs look at the entire life cycle of a product there is plenty of room for uncertainties in trying to estimate impacts. Thus, there is a lot of scope for people conducting the LCA to skew the data towards the result they want. They often leave out or downplay important parts of the life-cycle, for example, pesticides used in the

manufacture of jute are often taken into account when conducting an LCA of the jute industry. Since only 20% of jute farmers use pesticides this gives unfair weighting to the result. When data is not available, which is often the case, the author may make further assumptions or estimate quantitative figures.

LCAs OF JUTE AND WEIGHTING OF PESTICIDES

An LCA conducted on jute fabric compared to both polyester and cotton fabrics was recently undertaken by Natalie Hendriks, using the sophisticated software tool developed by Leiden University in 1990, SimaPro3. The conclusions were 'polyester is slightly more eco-friendly than jute, both jute and polyester are significantly more eco-friendly than cotton'. However as Hendriks pointed out, the difference in eco-points between jute and polyester is not significant because 95% of the eco-points are caused by the use of pesticides, based on a worst case estimation. 'This is unfair weighting in the system, since most jute is produced without using pesticides – only 20% of farmers use biocides.....Most jute is produced by small scale farmers who cannot afford pesticides and fertilisers.' Because there was no data available about the emissions (to soil, water, and air and plant uptake) of pesticides and fertilisers used, the same ratio as used with cotton was applied. [105, Hendriks]

LCAs rarely assess toxicity or hazard adequately as these characteristics are extremely difficult to quantify. The International Jute Organisation (IJO), while conducting its own study, found a number of disparities in LCAs of jute versus polypropylene (PP). Many studies done on the environmental impact of PP focus on PP production and not on the additives which can constitute up to 6% of the weight of PP. 'Since a complete balance of additives is not available, the environmental effects of PP usually indicates lower estimates.' They also found that calculations of energy consumption both in production and transportation of PP is based on a series of 'simplified assumptions' about types of fuel used. In their own study of jute versus polypropylene, the IJO acknowledged that there are vital issues that cannot be easily subjected to comparison in a LCA. The environmental effects of PP waste on farm animals and the impact of PP nets on marine wildlife (strangulation of dolphins, turtles and birds by abandoned, non-biodegradable nets) proved impossible to quantify.

Methodologies are not sophisticated enough to compare one form of ecological damage with another. For example, comparing the damage caused by climate change and toxicity is a controversial topic in the scientific community, and the values from one cannot be ascribed to the other. Therefore, it is not currently possible to fairly evaluate and compare the resource depletion of any non-renewable material with products made from renewable materials such as wood or bamboo.

The wider social issues arising from materials production cannot be accounted for in an LCA. It is impossible to give a numerical value to cultural heritage, the value of ancestral lands and homes, and clean water, air and soil, good health and kinship, social stability and a sustainable lifestyle.

Plastics and energy

How can one compare the embodied energy of a tree with the actual energy consumption involved in manufacturing plastics?

The plastic industry world-wide tries to show that plastics are environmentally friendly by focusing on the amounts of energy used in the production and transportation of plastics compared to competing materials. There are in-built assumptions in this criteria. In LCA terms energy usage is based on what energy can be measured, typically the consumption of electricity from the grid or captive power plants. How does one measure the amount of energy released by a tropical monsoon, (so-called ambient energy), to grow crops and renewable materials that provide sustenance for the many millions in India?

> 'In fact, all processes or work effected at ambient temperatures are discounted in the suzerainty of modern science. Thus, tribals, bamboo workers, honey bees and silkworms all process the resources of the forest at ambient temperatures, hence without the polluting side effects of waste-heat and effluent associated with big industrial processes. However, in the eyes of development, it is only the high energy input rayon and pulp units that really process the forest resources and contribute to economic growth and production.' [6, Alvares]

In the context of non-biodegradability, the Bhattacharya report argues that 'Plastics are more environmentally friendly as they consume less energy (in producing, processing and use) than competing commodity materials'. [43, GOI Bhattacharya] Since India is suffering a major shortfall in energy for industrial development, this is a politically powerful argument. In the forward to his report, Rakesh Mohan emphasises that 'petrochemicals (mainly plastics) are highly energy efficient compared to glass and steel etc'. [9, GOI Mohan] The point is made repeatedly at plastic industry conferences: 'In fact plastics consume less energy for conversion compared to many other materials. Lesser consumption of energy means lesser requirement of electricity or other energy resources, most of which pollute the environment'. [199, Bandopadhyay]

It is understood that the section of the Bhattacharya report dealing with the environmental impact of plastics was prepared by Reliance Industries, whose interest in championing plastic is obvious. The evidence they use comes from a ragbag of bits and pieces of old reports, data clearly selected to favour plastics. For example, they print a 1982 UK chart that compared favourably the energy content of plastics such as HDPE and PVC with steel, paper and glass. Presumably, the huge amounts of energy required to manufacture chlorine for use in PVC plastic is ignored. A later study on PET, sponsored by the Glass Packaging Institute in the US, arrives at somewhat different conclusions: 'Evidence in this report suggests that it takes about the same amount of energy to produce a 16 ounce glass container as it does to make an equivalent PET container.' Although HDPE appears to require somewhat less energy to make containers than either PET or glass, 'considerable energy savings can accrue by increasing the portion of recycled cullet (waste glass) used in glass production, particularly when large amounts of cullet can be obtained locally'. [206, Cole]

The Bhattacharya report contends that since plastic is lighter than glass it requires less fuel for transportation. His report makes precise calculations without indicating how these figures are arrived at. Obviously plastics are lighter than glass. Yet if there are many more glass container producing factories in India than plastic processing factories and the distribution of glass producers is geographically more evenly spread, then any comparative energy saving may well be lost by the greater distances that polymer containers will have to travel.

In a glass versus polymers analysis produced by Cole (Table 22) polymers have few advantages. The only factor in which plastics appear superior to glass is in lower emissions of nitrous oxide (NOx).

Table 22
Summary of the environmental advantages of glass and plastic containers

1. Environmental advantages of glass over plastics

Glass	Plastic
Simple production cycle	Complex petrochemical production
Process involves few points of Impact and Risk	Process involves many impacts and risks
Few hazardous inputs, few toxic emissions	Large amounts of hazardous chemicals, and toxic emissions
No serious chemical accidents	Many chemical accidents causing deaths, injuries and property damage
Recycled easily and economically	Difficult and costly to recycle
Closed loop bottle to bottle recycling	Generally recycled only once prior to disposal
Does not burn in incinerators	Highly compatible with incineration, often creating toxic emissions
Promotes recycling-based future	Promotes incineration; undermines recycling
No reported harm to marine life	Fragments and resin pellets harm sea birds and other animals

2. Environmental advantages of plastics over glass

High emissions of nitrous oxide -contributes to smog	Much lower nitrous oxide emissions

Source: [206, Cole]

Like Government of India reports, LCAs prepared for the petrochemical industry tend to focus on issues such as greenhouse gas emissions and energy use. They generally ignore the issue of toxic chemical emissions because they are notoriously difficult to evaluate and often highlight one of the key problem areas of the industry. When toxic hazards are included, plastics are generally lumped together without distinguishing between different types. Toxic by-products of use and disposal are rarely considered, and concerns about communities at risk or threats to public health from plastic products are ignored.

Qualitative advantage of LCAs

LCA, when reduced to *quantitative* information, is fundamentally a flawed tool. However, when used simply as a series of *qualitative* environmental indicators they can show where environmental

problems can occur in the life cycle of material and products. For example, the MET matrix examining the life cycle of jute (Table 14) clearly indicates the one areas of concern, the use of pesticides.

The Danish Environmental Protection Agency used a simple indicative matrix system to compare PVC to other materials. From a number of plastics, (polyethylene/polypropylene, polystyrene, PET, polyurethane and synthetic rubber) various wood materials and aluminium, only aluminium had as negative an environmental impact as PVC. [143, Danish Technological Institute] The Danish report was done by a government institution that, unlike Indian government committees, is not overtly influenced by industry. Such reports obviously have more credibility and value than studies done by institutes representing vested interests such as clay pipe manufacturers, glass packagers, the jute industry or, indeed, the petrochemical industry.

Looking holistically at production processes makes obvious sense but there are ways of doing this other than Risk Assessment and Life Cycle Assessment. Evaluating hazards is only one part of a holistic process. Other methods examine the national and global ecological capacity to support the consumption of products, even down to individual lifestyles.

Muddy waters

As government and industry and those affected by development become polarised, each understandably looks for impartial judgements – bring in the consultants. These 'experts' offer 'independent analysis' of one production method over another, by reducing materials and systems to quantifiable statistical and numerical data. However, consultants can be bought and sold, commissioned and interpreted. You too can 'choose your own LCA'.

All this claim and counter claim successfully muddies the water. Few people understand the complexity of the science, the number studies, graphs, and vested interests. As the debate continues, the cogs of industrial production keep turning. It is not in the interest of industry to necessarily win the debate. As long as its lobbying does not become too visible, it does them no harm. When under threat, all industry needs to do is create doubt in the decision-making process. This permanent ambiguity gives government an excuse not to act, and to watch the show.

14 Preventing pollution

'Cleaner production is the continuous use of industrial processes and products to increase efficiency, to prevent the pollution of air, water and land, to reduce wastes at source, and to minimise risks to the human population and the environment.'

United Nations Environment Programme, Government Strategies and Policies for Cleaner Production, 1994

A way forward out of the spiral of claim and counter-claim is to remove the need for the debate in the first place, to remove the 'debatable' chemicals and industrial processes. This demands a change of mind-set, from controlling pollution to preventing pollution, from trying to deal with hazardous industrial processes to changing processes and products.

Cleaner Production

Over the last ten years a new paradigm has entered the global environmental policy arena, that of 'Cleaner Production'. Waste reduction, waste minimisation, pollution prevention and source reduction are all ideas incorporated into this concept. According to the United Nations Environment Programme (UNEP), who promote cleaner production programmes, 'the key difference between pollution control and cleaner production is one of timing. Pollution control was an after-the-event, 'react and treat' approach; cleaner production is a forward-looking, 'anticipate and prevent' philosophy.

Prevention, as is well known, is always better than cure'. [207, UNEP] Pollution prevention and cleaner production are more-or-less interchangeable terms.

UNEP actively promotes cleaner production programmes in the 'developing' world.

> 'Cleaner production is now especially attractive to developing countries and those undergoing economic transition because it provides industries in these countries, for the first time, with an opportunity to 'leap frog' over older, more established industries which are still saddled with costly pollution control technologies.' [207, UNEP]

Cleaner production usually involves a thorough investigation of a company's entire production system, from use of raw materials through to distribution of the product. All branches of production including management need to be involved. In the course of these investigations new ways of preventing pollution can be found. In a Swedish light-fittings factory, for example, petroleum based oil was replaced with vegetable based oil, by-passing the need for hazardous chlorinated solvents and, as a bonus, lowered production costs

Cleaner Production in Sweden

A light-fittings manufacturer in Landskrona, Sweden, found it could not expand production to meet increased demand for its product because the regulatory authorities would not allow increased air emissions of a chlorinated solvent used to clean mineral oil from pressed light-fittings. Indeed, the authorities insisted that existing air emissions should be *reduced*. After investigation, cleaner production researchers from the nearby University of Lund found an alternative to the use of mineral oil and chlorinated solvents – a vegetable-based oil that could be cleaned off with soap and water. This not only eliminated the need for a highly toxic chlorine chemical but also saved the company money.

Cleaner production in India

There are several cleaner production centres in India such as the Cleaner Technology Information Network operated by the National Environmental Engineering Research Institute (NEERI) in Nagpur, the

India National Cleaner Production Centre in Delhi and the NGO, Development Alternatives. For the most part these institutions collect and disseminate information or conduct small-scale demonstration projects. They all rely mostly on external funding from UNEP and the United Nations Development Programme (UNDP).

The MOEF has made the development and promotion of cleaner technologies a key ingredient of its current environmental programme.

> 'With the assistance of the World Bank, the Ministry is establishing the Indian Centre for the Promotion of Cleaner Technologies (ICPC) as the co-ordination body for a network of expert institutions which will provide the necessary inputs in creating a database on available technologies, their relative performance and ranking, the source(s) from where the technology can be obtained, needed investments etc.' [193, MOEF]

The ICPC demonstrate projects on cleaner production and instigate training and awareness programmes for entrepreneurs in selected small-scale industries. However, it is an organisation with only a small number of links with mainstream industry. A number of hazardous industries have been investigated by cleaner production experts in India, such as textiles, leather and the pulp and paper industry, but so far plastics have not come under scrutiny.

The Precautionary Principle

An important policy instrument to implement cleaner production is the 'Precautionary Principle' or 'Precautionary Approach'. The Precautionary Principle is a key clause of UNCED (United Nations Conference on Environment and Development) in Rio de Janeiro 1992 Agenda 21 to which India is a signatory.

The argument behind this principle is that even in the best regulatory regimes it has proved almost impossible to establish *direct cause and effect* when it comes to the impact of complex hazardous chemicals on the environment and human health. Given the escalating environmental crisis there is often need to act before science can prove beyond doubt that a particular chemical is causing a specific problem. Action should be taken on the 'balance of evidence' and not conclusive evidence.

Fundamental to the Precautionary Principle is that the onus is on industry to prove that what they create is not hazardous to the environment or human health. It is *not* the responsibility of the community to prove that a specific industrial process is harmful. An environmental expert's conference held in Racine, Wisconsin, US in January 1998 defined the Precautionary Principle as follows:

> 'Existing environmental regulations and other decisions – particularly those based on risk assessment – have failed to adequately protect human health and the environment. There is compelling evidence that damage to humans and the world-wide environment is of such magnitude and seriousness that new principles for conducting human activities are necessary.
>
> Therefore it is necessary to implement the precautionary principle: When an activity raises threats to the environment or human health, precautionary measures should be taken, even if some cause-and-effect relationships are not fully established scientifically. In this context, the proponent of the activity, rather than the public, should bear the burden of proof (of the safety of the activity).'

Embracing the Precautionary Principle changes the role of both the regulatory authorities and science. Without conclusive proof of safety, precautionary policy would not accept a fixed level (for example, of chemical discharges to the environment, or human exposure to chemicals in the workplace) below which harm 'will not occur'. Regulators would set incremental standards of environmental performance by industry, with the aim of removing a hazard. A simple scenario would be thus. First, a process or a product is defined, on the balance of evidence, as potentially or actually hazardous, inefficient or resource hungry. Second, a standard is set for maximum emission standards and usage of resources and energy. Third, a progressively lower emission standard is worked out over an enforced timetable. This could eventually lead to the total elimination of a particular process or product.

Implementation of the Precautionary Principle thus involves the need for substitution and redesigning processes and products to reduce or eliminate hazardous or potentially hazardous industrial

processes and products. For example, with plastics government and industry could work together towards total elimination of PVC in, say, 10 years time. The intermediate stages would be gradual PVC replacement, product by product, PVC to PP to bio-plastics/glass/wood/bamboo etc.

The Precautionary Principle at work

Legislation such as US State, Massachusetts' Toxic Use Reduction Act aggressively applies the Precautionary Principle. The Act reduces pollution by directing industry to substitute less hazardous materials, by optimising production technologies and redesigning products. It requires companies to report annually on their use of toxic chemicals and prepare comprehensive plans showing how they are committed to reduce their use. This law does not ask what levels of chemicals are safe, but rather how to redesign production to avoid their use and potential risk altogether. The law calls for companies to assess alternatives and evaluate what can be done to reduce or eliminate hazards. Between 1993 and 1995 toxic by-products generated in Massachusetts (which include all wastes, releases, recycled and treated waste materials) declined by 30%.

Some countries, such as Sweden, already take a Precautionary Principle to much of its chemical policy. Sweden's interpretation of the Precautionary Principle includes a substitution clause enacted in 1991. 'Anyone handling or importing a chemical product must take such steps and otherwise observe such precautions as are needed to prevent or minimise harm to man or the environment'. This includes avoiding chemical products for which less hazardous substitutes are available. The law also states that 'a scientifically based suspicion of risk shall constitute sufficient grounds for the government to take measures against a chemical.' To avoid restrictions on a chemical, the producer must show the suspicion is unfounded.

As we have seen with the Plastics Task Forces (NPWMTF) and Government committees, science is often co-opted to serve the vested interests of the conflicting parties (government, industry, scientist, environmental NGOs and the affected community) to conclusively establish that an industrial process or product is harmful or safe. In a precautionary scenario it is not necessary. A key role for science would not be to establish proof or otherwise of wrongdoing. Rather first contribute to the 'balance of evidence' by sampling and

analysis and then monitor that progressive change was taking place for example, to reduce emissions of possibly harmful chemicals.

In Europe, Denmark referred to the Precautionary Principle when it banned the use of phthalate softeners in PVC plastic baby toys. It is now devising a chemical policy that by 2005 would withdraw all 100,000 chemicals in use that have not been adequately tested. Denmark is the first country to act on the fact that less than 2% of all chemicals currently used globally have been fully tested for toxicological effects.

The Precautionary Principle in Indian law

In the 'Vellore Citizens Welfare Forum', a case initiated by the local community against several tanneries releasing untreated effluent, the Supreme Court of India held that the Precautionary Principle is part of the law of the country

Precautionary Principle defined in Indian Law

The Madras local community approached the Supreme Court under A.32 of the Indian Constitution to enforce their fundamental right to a clean environment. The petition was filed against several tanneries that were releasing untreated effluent into the water source of the local community and agricultural lands. The Court, headed by Justice Kuldip Singh, severely chastised the industry and the Government for failing to carry out their statutory duties, and gave ruling on the Precautionary Principle as follows:

'1. Environmental measures, by the Government and statutory authorities, must anticipate and prevent the causes of environmental degradation.

2. Where there are threats of serious and irreversible damage lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

3. The onus of proof' is on the actor or the developer/ industrialist to show that his action is environmentally benign.' [208, Supreme Court]

The Supreme Court described the Precautionary Principle as part of the law of the country as the Constitution guarantees to every person 'protection of life', which includes an adequate standard of living, public health and clean environment. The Court said that the rules of customary international law are deemed to be incorporated

into domestic law, if they are not contrary to the domestic law. Therefore, a person has an 'inalienable common law right for a clean environment'. The Supreme Court felt that 'these rights cannot be adequately protected without implementing the Precautionary Principle'.

Practical progress to a sustainable future

Any practical progress towards such a change must be attained in bite-sized stages. The modern industrial economy has become very complex, and any radical change in policy could result in large-scale loss of employment, and resultant hardship for communities. As with the implementation of the Precautionary Principle, the stages must be attainable, not insurmountable. A preventative approach sets achievable targets that become incrementally more stringent. The aim is to gradually decrease hazards and at the same time encourage cleaner production methods.

This process could be broken up into three main stages:

➧ Knowing

Moving to a sustainable future requires us to recognise that we are recklessly polluting the environment and using resources in an unsustainable way. For us to do this information on pollution, resources and planning processes needs to be known, understood and freely available.

➧ Improving

In the short-term steps can be taken to limit pollution by changing production processes and products. This will require government to employ a range of policy options that encourages industry to move towards cleaner production or eco-efficiency.

➧ Sustaining

As we will outline in the next chapters, we need to evolve socio-economic systems that will not only drastically reduce pollution but also reduce the use of material resources. Any production process must 'meet the needs of the present without compromising the ability of future generations to meet their own needs.' [24, WCED]

Knowing: Right to Know

Indian Government planning processes normally take place behind closed doors. The various government planning reports for the petrochemical sector that we have referred to are difficult to obtain. As we have seen, decisions are based on a series of assumptions, some of which are erroneous and which in their totality will have an affect on enormous numbers of people. Without information it is difficult to see how industry, government and the public can participate in challenging these assumptions and effecting change towards a sustainable material policy.

The Cambridge World Bank Report, 1996, says: 'Given that enforcement agencies in India are weak, the capacity of the public to bring pressure on polluters must be strengthened. This cannot happen without a formal and transparent public disclosure process.' [190, Cambridge] Public participation is acknowledged in theory by the Indian National Productivity Council (NPC) 'Pressure from environmental groups and the public in general is necessary for proper environmental management. In the absence of such an approach the management tends to adopt a lackadaisical approach.' [209, Chandak]

Openness with information is often perceived by industry and government as a hindrance to development. But in the long term open debate leads to consensus and participation, rather than the more common confrontation, delays and even higher costs. Public participation should occur in the initial stages of planning, when assumptions are being formed and can be openly debated. The concerned public needs to have ready access to a whole range of information, technical, legal, political, scientific, financial etc. The same information should be available to government and industry in their decision making processes.

Information is notoriously difficult to obtain in India. It is often incomplete and mechanisms for challenging the information or implementing change are not well defined. Environmental planning information is reluctantly parted with. The 74th amendment to the Indian constitution, the Nagar Palika Act, mentions the formation of Ward Committees which should include NGOs in each Municipality, and to which all Environmental Status Reports (ESR) should be made available. (An Environmental Status Report is a comprehensive report on the status of the local environment.) In practice, no criteria are set by which these NGO's are to be selected to the committee. An

ESR report is not easily obtained. If it is, there is no mechanism to contest the data or question the methodology used. [210, Hoosein]

'Official Use Only'

'In the traditional caste society of India, based on hereditary division of labour, information was compartmentalised in the extreme.' In colonial times the function of the colonial establishment and its Indian allies was predominantly one of subjugation. The establishment did not want to be questioned by the subjects and therefore shielded itself behind an Official Secrets Act. According to Gadgil and Guha this control of information has been substantially maintained by the new ruling elite of independent India. 'So, despite the ushering in of a democratic government and elected legislatures, the state apparatus continues in the way of the colonial state in refusing to share any information with the public. The Official Secrets Act remains intact, all government papers are marked 'Official Use Only', and members of the public have no access to information of vital interest to them.' [26, Gadgil and Guha]

Yet there is some effective challenge to this closed system. Sections of the media and environmental activists in India have campaigned vociferously for change. With radio and television controlled by the state, the print media have played an important role in reporting, interpreting and publicising conflicts in modern India. Among the most notable have been the citizens' reports on the state of the Indian environment published by the Delhi-based Centre for Science and the Environment (CSE), and Kerala's popular science movement's publications. Popular magazines such as 'India Today' and 'Outlook' have also played the occasional part. International aid for environmental improvement, 'Environmental Capacity Building' and the like now comes with the attached string of involving local NGOs and the community in decision making.

Information on industrial hazards

In order to reduce and eliminate the use of toxic materials in plastic production, the amounts and types of chemicals and materials used in the manufacturing processes and products must be identified and quantified.

In the US the Emergency Planning and Community Right to Know Act was enacted in 1986 after the Bhopal chemical tragedy.

This Indian tragedy made US citizens realise the catastrophic consequences of lack of information about the types and amounts of hazardous emissions from factories. In 1987 the Toxic Release Inventory (TRI) was made law in the US and each year the government actively disseminates information about various companies' hazardous emissions to air, water, sewers and land. US companies must also report the amount of chemicals transferred to waste disposal options such as incineration, deep well injection and on-site and off-site recycling. Over the years the inventory has improved to cover over 650 chemicals and a larger segment of US industrial sectors.

Citizens in the US are now pushing for a Chemical Use Inventory that would measure the amount of chemicals in products themselves. This is not quantified in the TRI. Following the recommendations for the public Right-to-Know made in the Rio Declaration of 1995, the Organisation for Economic Co-operation and Development (OECD), has issued a Guidance Manual for Governments about Pollutant Release and Transfer Registers (OECD, 1996).

In one state of the US, Massachusetts, legislation necessitates that companies provide all the necessary information for the public to understand how hazardous its processes and resultant products are. The Massachusetts Toxic Use Reduction Act (TURA) requires every company to prepare an annual toxic 'user education plan'. This plan quantifies how much hazardous material is used in the production process and the fate of the material either as emissions to air, water or for disposal, as well as how much hazardous material is used in the final product. By such measurements manufacturers can begin to reduce their use and substitute safer chemicals and materials. The success of TURA is also due to the training and help supplied by the local university to ensure producers have access to information about clean technologies. Another important factor is that all plan summaries have to be made available for public inspection.

Environmental statements by companies such as Reliance Industries are not precise enough for the public to understand the impact their production processes are having on the environment and health. They are more or less public relations exercises. From their 1997 Annual Report: 'Reliance has sought to continuously reduce the pollutant load on the environment by controlling the quantity of

pollutants at source, adopting more environment friendly processes and by recycling streams that yield organic pollutants.' [60, Reliance Industries] Consensus decision-making can only be effective when based on full information disclosure, which means providing primary data, which at present, no industry in India does. The MOEF issued a notification in 1992 for every industry to audit stocks and consumption of raw materials, outputs, wastes, methods of disposal, and the environmental impact on its surroundings. [211, UNEP] We have no evidence that this has been implemented.

In the US, Material Safety Data Sheets are compulsory for workers. These sheets stipulate what materials workers are subjected to and what the risks are from exposure to these chemicals. Access to such information has enabled many states, such as New Jersey, to pass the Worker Right to Know Act. In response to public and worker pressure, New Jersey also has a fully functional Toxic Use Reduction programme in place. Increasingly companies will be held responsible for their labour practices and already major retailers and producers are signing the SA8000, or Social Accounting audit, which guarantees a minimum wage and worker rights.

Product labelling

Consumers need access to information about manufacturing processes and product ingredients. This is particularly true with regard to plastic where many consumers are concerned about the potential toxicity, but have no means of knowing which plastic and what additives are used in which product. A consumer may not wish to purchase a hazardous material such as PVC. Plastic product labelling will, like food labelling, offer consumers choice. The National Plastics Task force authorised the Indian Standards Institute to institute a programme of labelling plastics, describing their different plastic types, using a simple numbering or picture method. This information is for public education as well as to make it easier for the waste segregators (ragpickers) to separate plastic waste.

Substitution

As we have seen in the example of a light-fitting manufacturer in Sweden, cleaner production experts often solve pollution problems by substituting a non-hazardous chemical for a hazardous chemical, to make the same product. It can also mean using a less hazardous

material for another (PET for PVC bottles), or one product for another (glass for plastic bottles) or one entirely different industrial process for another (using a water purifying system instead of bottled water). It could also entail substituting a sustainable traditional industry for a hazardous industrial process (clay kulhads instead of plastic cups), in broader socio-economic interests.

All plastics except bio-plastics create environment and health hazards in their production processes, and some in their use and disposal. A key element of a substitution policy would aim towards the elimination of all hazardous materials through a process of gradual phase-out, with the most hazardous materials prioritised for elimination, with plastics this would be PVC. The least harmful of existing plastics such as the polyethylenes and polypropylene could be accepted as 'interim' materials. The phase-out procedure would need to coincide with new developments of less harmful 'interim' polymers, such as co-polyesters for specific 'unique' applications and, in due course, they could be replaced by bio-plastics.

It requires political will on the part of government to ban and phase-out particularly harmful products, and thereby to steer industry in a more environmentally acceptable direction.

PVC BANS, PHASE-OUTS AND PRODUCT LABELLING

- Concerns about fire have led some local authorities to ban or restrict the use of PVC in public buildings, mostly in Germany.
- Over 50 cities in Spain have approved phase-out measures for PVC. Consumer pressure has moved the production of mineral water bottles from PVC to PET in Spain.
- In November 1999 the EU banned six toxic softeners (phthalates) found in soft PVC toys.
- The Russian Federation has introduced a 'totally chlorine free' label for products, which would include PVC products.
- In January 1998, the Czech Republic has banned the production and import of packaging made of PVC from 2001.

Industry could take a lead by rejecting hazardous materials. Sports shoes manufacturer, Nike has recently committed to stop using PVC. In a statement made in July 1998 they said, 'Extensive scientific studies of polyvinyl chloride (PVC) have linked both the manufacture and improper disposal to the use and by-product generation of substances that are known to be, or suspected of being harmful to living systems. In keeping with Nike's corporate goal of adopting 'sustainable business practices', Nike will not continue to support the production and use of PVC'. Nike has also implemented a 'no PVC' regime at its new European headquarters in the Netherlands. All suppliers and contractors have been asked to ensure that no PVC materials or products are used in connection with the construction and fitting of the site. All piping for the electricity, sewage, grey water and the heating system is PVC free.

It requires developing new and alternative technologies. Often these new materials have marked advantages in performance over ones they are replacing. US Eastman Chemical Company opened up 'the world's most advanced co-polyester plastics manufacturing facility' in Malaysia in May 1998, manufacturing Eastar and Spectar, the so-called 'plastics of the future'. The co-polyester is being targeted to replace PVC because of its superior environmental and material performances. 'They are easy to recycle,' said Eastman Vice-President J. Wiley Bourne. 'They are safe to incinerate. They do not pollute the ground water, being composed of carbon, oxygen and hydrogen and not containing nitrogen, sulphur or halogens. They use no plasticisers or other stabiliser. The industry is now heavily dependent on more environmentally friendly materials. The recyclability of Eastar and Spectar co-polyesters is driving growth in such applications as transaction cards, pricing tags, packaging tubes, graphic arts media, furniture laminates and vending machine facing'. About 90% of co-polyester plastics from this plant will be exported to the Asian region, with the bulk of it going to Japan and China, 'where demand for the products is growing rapidly, due to the strength of the plastics as well as being environment-friendly compared to PVC or polycarbonate'.

US COMPANIES DEVELOP ALTERNATIVES TO PVC

The Cryovac division of Sealed Air Corp., (the firm that ranked second in Plastics News' 1997 survey of North American film and sheet manufacturers) has phased out PVC shrink film in paper products and PVC stretch film for poultry packaging, replacing them with multilayer films combining linear low density polyethylene and ethylene vinyl acetate. In paper products, the LLDPE/EVA film offered 80% maximum shrinkage, compared with 50% for PVC film.

Dow Chemical Co is aiming metallocene PE at medical bags, a market presently dominated by PVC. In testing at Dow's research labs in Midland, Michigan, US, metallocene PE film bags fared better than PVC bags.

Solvay Engineered Polymers, a Texas firm, has developed polypropylene-based flexible polyolefins aimed to replace PVC in auto body side mouldings. Dennis Slatton, Solvay product development engineer, said Sequel products provide excellent dimensional stability and cost savings of as much as 10% over PVC.

Perhaps the most significant move away from oil-based plastic, not in amounts of plastics but in consumer awareness, happened in December 1999. As a result of public concerns about the dangers of phthalate softeners in PVC toys, Mattel Inc, the world's leading toy manufacturer announced that they would remove PVC from its toys and switch to bio-plastics. Mattel plan to start production of bio-plastic toys as soon as 2001. Henceforth, early in the new Christian millennium, Barbie will be made from plants and not fossil fuels.

Policy Options

Governments can use a number of policy and legislative means to encourage industry to develop processes and products that will not harm the environment and health. Voluntary agreements, training programmes and dissemination of information all have their part to play. However, none can replace 'command and control' policy, employing physical regulations, implemented through a legal framework.

Planning can be used to stimulate cleaner production. The planning process for new industrial development should clarify the future policies of the authorities and make the standards expected clear. Industry can then anticipate these changes into its own planning.

Ideally, planning permissions would be restricted for hazardous non-sustainable industries, such as the petrochemical industry.

Permits to discharge waste into the environment should integrate all media - air, water and soil and should also include 'means' and 'target' prescriptions. Means prescription should specify that cleaner production technology should be employed. Target prescriptions would provide industry with clear goals.

Additional instruments, which are not explicitly public law but proving to be useful, are *liability* and *strict liability*. Liability can be used to stimulate industry to take preventative measures. They will only be persuaded do so as long as the costs of prevention do not marginally exceed the cost of the expected damage. Liability occurs if companies fail to comply with legal standards (for example discharge permit standards). Under strict liability procedures, companies are responsible for any damage caused by their production processes and products even when they have fulfilled their legal obligations. To minimise risks, companies will increasingly employ proactive and preventative measures. Therefore, strict liability provides more opportunities for the promotion of cleaner production.

Pricing the environment

Governments in the north have taken to using a variety of fiscal measures like *environmental charges*, and a number of other economic instruments such as *differential taxation* and *subsidies*. They are attractive to governments because they act directly and are less costly to administrate since existing departments of government (for example taxation) can set charges and collect revenue.

Examples of environmental charges

1. Effluent charges. These are charges on discharges into environmental media, based on the quantity or quality of the discharged pollutants.

2. User charges. These are payments by industry for the costs of collective or public treatment of effluents.

3. Product charges. These are charges laid upon the price of products which are polluting in the manufacturing or consumption phase or for which a disposal system is implemented.

4. Administrative charges. These are payments for the services of the authorities, for example, for the permit granting procedure.

When calculating the price of its goods, industry usually does not take into account environmental costs. *External* costs such as using the environment as a receptacle of waste are rarely *internalised* into the costs of products to the consumer. This neglect, say the Erasmus Centre for Environmental Studies in the Netherlands, is both a government and a market failure. The root cause of this situation is that the environment has different alternative functions. Erasmus defines the four major competing functions of the environment:

1. As a consumption good such as drinking water, breathing air, and for recreation
2. As a receptacle for wastes.
3. As a supplier of raw resources.
4. As a location of space.

Costing the uses of the environment, whether as a receptacle of waste or a source of raw materials, should not be open to the highest bidder, but rather ensure that it is used less casually and wastefully. However, the price agreed between industry and government for using the environment as a 'scarce good' could be, and often is determined by what industry will pay and still keep its activities profitable. As a result the use of the environment as a scarce good, is unbalanced, an inefficient and short-sighted exploitation of natural resources. [212, Erasmus Centre for Environmental Studies]

A major problem with using charges is that they can treat the environment as just another resource that can be priced like any commodity. As a system it fails to recognise the intrinsic value of the environment, and that many raw resources exist in finite and rapidly depleting amounts. It does not accept the limits of nature, but rather the unlimited needs of man.

Differential taxation and subsidy

Taxation can work as a negative or positive product charge. Differential taxation promotes the use of more environmentally friendly substances and products by levying taxes and surcharges on the use of hazardous substances or products. This creates an incentive for industry to develop and use cleaner materials and processes. It should not be used as a means of collecting extra taxes, or enabling industry to pay off its malpractices, a method not unheard of in India, or elsewhere. Differential taxation is used in

Simla, for example, where paper bag manufacturers have been exempted from taxation thus making plastic bags less competitive.

Subsidy has long been a feature of government policy in India, mostly in the form of handouts in times of drought, flood or famine or of free energy and fertilisers to farmers. Prices of some basic staple foods are subsidised to limit the impact of inflation on the poor. It is important here to differentiate between passive and active subsidy. While responsible government may well be expected to passively subsidise the destitute it is better to subsidise activities that can lead to self-sufficiency. In communist-controlled West Bengal some jute mills have become state owned and jobs guaranteed. However, this has not prevented the jute industry from becoming increasingly threatened by polypropylene bags or helped improve productivity and efficiency. Subsidising employment should have been coupled to 'incentive' measures, such as improving jute quality, mill equipment and marketing skills.

Perverse subsidies

'Ideally subsidies are supposed to exert a positive influence by helping people, industries, regions or products that need to overcome cost, pricing or market disadvantages. Perverse subsidies do the opposite. They function as disinvestments, leaving the environment and the economy *worse off* than if the subsidy had never been granted.' [14, Hawken] In the renewable energy sector, India has subsidised wind-energy turbines by giving tax-breaks on the purchase of the hardware. Since the government was subsidising the turbines, the Indian entrepreneur was less concerned with their performance. Obsolete and inadequate technology was bought,some of which has never worked at all. A more effective subsidy would have been to pay a premium price for energy generated by the wind turbine, giving the power generator a vested interest in buying and maintaining the best technology.

Many of India's vital resources are perversely subsidised. Timber and bamboo are sold cheaply to paper pulp mills to the detriment of forest dwellers and craft artisans. Water is subsidised for irrigation and farmers benefit from subsidised synthetic fertilisers and energy. It has led to over-use of water and fertilisers and depleted water and soil resources for both rich and poor. In these cases it is not the service required that has been subsidised (provision of energy, food

or paper), but the material commodity (wind turbine, water, forest,) and as such it has been the commodity or material that has suffered, and the service often unsatisfactorily fulfilled.

Used as an incentive, subsidies for developing sustainable technologies, can be a powerful tool for helping these technologies gain market share. Subsidies, by means of grants and money for research programmes would stimulate the development of bio-plastics.

Extended Producer Responsibility

Extended Producer Responsibility (EPR) is an emerging principle for a new generation of pollution prevention policies that focus on products instead of production facilities. The aim of EPR is to encourage producers to prevent pollution and reduce resource and energy use at each stage of the product life cycle through changes in product design and process technology. EPR uses the full gamut of policy options including regulations, standards, bans, taxes, subsidies and labelling.

Possible EPR legislation

- mandatory take-back
- minimum recycled content standards
- secondary materials utilisation rate requirements
- energy efficiency standards
- disposal bans and restrictions
- material bans and restrictions
- product bans and restrictions.

Economic instruments that embody EPR include:

- advance disposal fees
- virgin materials taxes
- removing subsidies for virgin materials
- environmentally preferable products procurement.

Information instruments that embody EPR include:

- seal-of-approval types of labelling (e.g. Green Seal, Blue Angel)
- environmental information labelling e.g. energy efficiency, CFC use)
- product environmental profiles that pass from one stage of the life-cycle to the next
- product hazard warnings
- product durability labelling.

Most information 'approaches' place the primary responsibility on the producer to develop and provide information, either voluntarily for market advantage or as a regulatory requirement. (Greenpeace 1995)

In its widest sense EPR is the principle that *producers accept responsibility for the environmental impact of their products*. This includes

upstream impacts, arising from the choice of materials and from the manufacturing process and downstream impacts, from the use and disposal of products. Producers comply when they accept legal, physical, or economic responsibility for the environmental impacts that cannot be eliminated by design.

The model example of EPR is *product take-back* where a producer takes back a product at the end of its useful life (when discarded), either directly or through a third party. This model is not new to India where refundable deposits on refillable glass bottles for beverages are common. However, when 'plastics return to manufacturer' was proposed by the CPCB in the National Plastic Waste Management Task Force meetings, it was rejected overwhelmingly by industry (described in Chapter 10).

Take-back of plastic bottles

Plastic bottles litter the landscape of tourist India. No one wants them – the ragpickers or the originators. The only way to solve the plastic litter problem is for the manufacturers (and distributors) to accept responsibilityv for dealing with the waste they create and profit from. As a first step, the plastic bottle would have to be made of truly recyclable plastic – probably PET, and labelled as such. The second step would be to instigate a deposit scheme to ensure the bottle was returned to the retailer – in the same way as glass bottles are deposited and returned.

Instead of operating in a separate haphazard market, ragpickers would be employed by manufacturers or distributors as an integrated part of the collection system. It would ensure the bottles no longer littered. The same transport system that delivered the bottles would return them to the producer. The same production technologies (for example extruding and moulding) used to manufacture virgin bottles could be used for making recycled bottles.

In Europe EPR legislation is currently being used with some success to deal with post-consumer wastes, mostly non-biodegradable wastes arising from vehicles and electronic scrap. The process of formulating this legislation has enabled the European Union (EU) to push for the phase-out of hazardous materials in these products. ACEA, the European car manufacturers' association, has accepted this legislation and is only arguing about when it should come into force.

In a global economy 'carmakers, particularly in Asia, will come under pressure to follow suit'. [213, Smith] 'By the end of 1998, some 28 countries had implemented take-back laws for packaging, 16 for batteries and 12 were planning take-back requirements for electronics.' [14, Hawken]

Extended Producer Responsibility is an extension of the Precautionary Principle into product stewardship. If fully embraced by government and industry, it would stop the need for many regulatory sticks and carrots.

Placing onus on the producer, not the community, to bear the burden of proof and responsibility would clearly help unlock the impasse of claim and counter claim that exists now in India, particularly with hazardous industry, including petrochemicals. This changes the role of government, science and indeed the public from one of establishing proof about the effects of harmful activities doing to one of monitoring industrial activity, to observe that improvement is taking place. Industry is returned to being a servant of society rather than its tormentor.

How to control and enforce

Environmental legislation is rarely enforced in India. 'Industries do not therefore have the regulatory burden, and can afford to delay action. Industries only perceive the costs of compliance and there are no incentives to explore the prospect of efficiency or productivity improvements.' [214, Patwardhan]

The technical solutions currently being employed by India to reduce hazards in industrial processes, for example its end-of-pipe technologies such as CETPs, are not working, and never will. The 'preventative approach' sets *ever more* stringent target standards, which allow fewer and fewer pollutants to be emitted. In this way industry is chanelled into the only option of employing cleaner materials and methodologies. Industry is forced to look at different processes, other than using hazardous substances, to produce the same goods or different goods that provide the same services. In this scenario strict enforcement of regulations and standards and use of economic instruments is vital.

Where 'command and control' legislation is rigorously enforced, the regulatory stick – fines for polluting activities, or banning products – is often not required. When faced with a strong and

effective regulatory regime, industry will anticipate the need for change and move quickly to gain a market advantage with new, cleaner processes and products.

Japan moves out of PVC

Regulatory authorities in Japan began to measure for dioxins arising from municipal waste incinerators and found in humans and breast milk. The 1996 annual study by the Japanese Environment Agency found the bottoms of 16 water bodies 'to be contaminated with highly toxic dioxin, representing an 8-fold increase from the previous year, while water bodies containing contaminated fish increased 12.5 fold from the previous year to 25'. Identifying PVC as a significant source of dioxin from incinerators and primary production processes, the regulatory authorities began encouraging manufacturers and retailers who used PVC for packaging to source alternative, less environmentally harmful polymers.

From 1997 onwards, Japanese industry, one of the world's biggest manufacturers and consumer of plastics, woke up to threats posed by PVC and are now moving into alternative polymers. Shiseido, Japan's leading cosmetic company decided to use polypropylene and other materials for all cosmetic containers by March 1999. The biggest electric cable manufacture in Japan, Sumitomo Electric Industry, announced in May 1998 that they would ban PVC for general electric cable. [215, Yomiuri]

The limits of cleaner production

Does 'cleaner production' point the way? Certainly preventative policies will help internalise the costs of dirty industries and make 'cleaner' industrial processes more competitive and more attractive for industrialists. Cleaner production is still a path that has to be regulated, fined and taxed, where vested interests become tangled, and every inch is fought over. More technologies, even clean ones, add to complexity and are often only temporary fixes to a system that is fundamentally destructive.

> 'Capital, bureaucracy and science – the venerable trinity of western modernisation – declare themselves indispensable in the new (environmental) crisis and

> promise to prevent the worst through better engineering, integrated planning and more sophisticated models. Fuel-efficient machines, environmental risk assessment analyses, the close monitoring of natural processes and the like patch technology onto technology.' [23, Sachs]

Some of these policies are careful not to seriously disturb the industrial status quo. The UNEP cleaner production programmes emphasise profitability – if you change to this process now, then long term profitability will ensue – which is not necessarily sustainable. The policies that only address profit and volumes are based on the dominant ideology of post-war development - the conversion of nature into a resource for commodity production and capital accumulation.

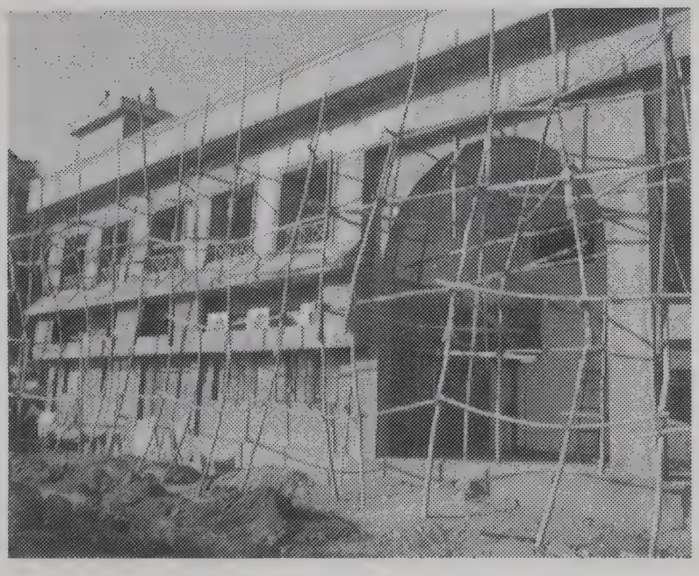
> 'Unwilling to reconsider the logic of competitive productivism which is at the root of the planet's ecological plight, it reduces ecology to a set of managerial strategies aiming at resource efficiency and risk management. It treats as a technical problem what in fact amounts to no less than a civilisation impasse – namely that the level of productive performance already achieved turns out to be not viable in the North let along for the rest of the globe.' [23, Sachs]

Environmental charging systems go against the grain of a culture that has lived successfully within the limits of nature. Although they aim to increase the value of nature and thereby preserve it, by their own logic it means that nature is available to whoever can pay the highest price. And let market forces rule.

15 Sustainability through capitalism?

'Within one generation, nations can achieve a ten-fold increase in the efficiency with which they use energy, natural resources and other materials.'

Hawken, Lovins and Lovins, 'Natural Capitalism', 1999



As well as ensuring profitability, programmes such as 'cleaner production' deal only with the *symptoms* of our profligate use of resources, namely pollution and waste.

> 'Industry moves, mines, extracts, shovels, burns, wastes, pumps and disposes of about 1.8 million kgs of material in order to provide an average middle-class US family's needs for a year. In sum, US citizens waste or cause to be wasted nearly 500,000 kgs of materials per person per year. The rest of the world appears to be aspiring to an economy like that of the US, but has 21 times as many people.' [14, Hawken]

Pollution prevention programmes do not address the fundamental problem, that our current use of resources is unsustainable. From Schumacher onwards the clarion call of those who are trying to resolve the growing strain on our living systems is for us to address the *cause*, the overexploitation of our stock of natural resources and our wasteful use of them. Dr Karl-Henrik Robert, a proponent of long

term sustainability, used a graphic image to describe our short-term limited vision and the way forward:

> 'Up to now much of the debate over the environment has had the character of monkey chatter amidst the withering leaves of a dying tree – the leaves representing specific isolated problems. In the midst of all this chatter, very few of us have been paying attention to the environment's trunk and branches. We must learn to deal with environmental problems at the systemic level; if we heal the trunk and branches, the benefits for the leaves will follow naturally.' [17, Robert]

Sustainability

Over the last two decades environmental policy-making has been gradually integrated into the broader sphere of sustainability. Sustainable Development became a catch phrase of the late 20th century. One definition (and there are many) is 'improving the quality of life while living within the carrying capacity of the supporting ecosystems.' [216, IUCN]

The term 'Sustainable Development' first came to prominence in the World Conservation Strategy (WCS) published by the World Conservation Union in 1980. It achieved a new status with the publication of 'Our Common Future', the Brundtland Report in 1987. Since the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 many countries agreed to address sustainability issues and co-ordinate national responses to the United Nations Commissions on Sustainable Development (UNCSD). National councils for sustainable development have been set up in more than 130 countries since 1992 and more than 50 countries have initiated official government mechanisms to formalize participation with the public and other stakeholders. [211, UNEP]

The various reports and conferences emphasise the growing need to take action to sustain the ecosystem, but they all fall short of reconciling our current economic growth paradigm with ecological limits. While the Brundtland report accepts conventional economic growth as a de facto paradigm, it recommends changing the *quality* of growth – to reorganise economic activity to meet prioritised human needs. To do so it suggests ecological criteria and social

equity must regulate growth. Unresolved in all the reports is the increasingly dominant part played by economically more powerful institutions, in particular their influence on the fundamental problem of inequality, and the control/ownership of resources.

Sustainable Development has come to mean different things to different sectors of society. For some environmentalists the term is an oxymoron in that 'development' is seen as conflicting with 'sustainability'. Yet the word 'development' can be applied to improving human and social welfare as well as promoting industry and trade. Latterly, sustainable development has been appropriated by sections of industry.

> 'In the post-UNCED age, sustainable development and environmental issues have folded into each other. While this has led to a deeper understanding in the international community of the relationship between environment and development, especially in the south, it has also played into the hands of MNCs, which can place virtually any project or practice with economic implications under the sustainable development umbrella.' [218, Bruno]

Sustainable growth economics

In 1999 the Untied Nations Development Programme (UNDP) began a programme of co-operation with some of the world's largest and historically most destructive corporations. The joint programme is called the 'Global Sustainable Development Facility (GSDF)' or 2B2M (2 Billion People to the Market by 2020). In the name of developing the 'Third World', and alleviating poverty, the UNDP is prepared to offer a brighter 'sustainable' image to companies such as British Rio Tinto plc and others who are well known for their negative impacts on human rights and the environment. The purpose of the GSDF/2B2M project, in the UNDP's own words, is to 'create sustainable economic growth and allow the private sector to prosper through the inclusion of two billion new people in the global market economy'. In other words, the UNDP is claiming the lives of the world's poorest two billion people can or will be improved by drawing them into a ruthless world economic system dominated by a few hundred giant corporations – including the GSDF sponsors. [219, Karliner]

Sustainable systems

In the 1990s, research institutes, ecologists and academics attempted to reconcile the conflicts between ecology and economics; how the growing numbers of humanity could have access to an adequate level of materials without further depleting the finite store of the planet's resources. The concepts and systems they have evolved share two fundamental principles – the importance of understanding and living in balance with nature, and the need to value the earth and to reduce the use of its resources. As Hawken and Lovins say, 'We don't need to invent a sustainable world – that's been done already. We need only to learn from its success in sustaining the maximum of wealth with the minimum of materials flow'. [14, Hawken]

Many of the policies in cleaner production are utilised, for example, the Precautionary Principle, but they are extended within a broader framework of a number of whole system approaches. Many concepts are similar. Their main differences lie in their priorities and visionary 'envelopes'. The term 'Clean Production', as developed by Greenpeace International and NGOs such as Clean Production Action, also incorporates these concepts into a series of principles by which production systems should operate in order to be sustainable, outlined in Annex 4.

The Natural Step

One of the most straightforward approaches is the 'The Natural Step', devised by Swedish cancer specialist Dr Karl-Henrik Robert. 'Our aim is for human needs to no longer diminish the quality and quantity of life-sustaining natural resources (e.g. air, water, etc). Our aim is for the economy and ecology to be seen as inseparable for sustainable development and quality of life.' The Natural Step Foundation evolved a *checklist* for sustainability based on four fundamental ecological principles that look at the earth and nature as a whole. Any business activity can be checked to see how it observes or violates these principles. [17, Robert]

1. Does the action reduce the use of finite mineral resources?
2. Does the action reduce the use of long-lived synthetic products or molecules?
3. Does it preserve or increase natural diversity and the capacity of ecocycles?

4. Does it reduce the consumption of energy and other resources?

Essentially, Dr Karl-Henrik Robert wants to move the environmental debate beyond his chattering of monkeys and our 'claim and counterclaim'. If a politician asks a group of researchers, 'Are plastics eco-friendly?' he will receive a number of conflicting answers, largely based on defining the question. Decision-making becomes difficult. If we start from the more basic level of these provisions for sustainability, the answers will be clearer and provide better practical guidance.

Using these four principles, The Natural Step analysed the plastics industry and found that it clearly violated three of the system conditions.

Plastics violate principle 1 by using oil as a raw material. 'The industry sometimes argues that only 4-5% of the total oil production goes into plastics manufacture. But looking at the total consumption of oil, 4-5% is, in fact, quite a lot.'

Plastics violate principle 2. 'First, the production of plastics today gives rise to persistent synthetic substances that eventually will leak into the environment. These substances are, for instance, halogenated like chloroparaffins (in the case of PVC). Second, the production of plastics generate unintended persistent synthetic substances during chemical processes or incineration.' (An example is the production of dioxins during incineration of PVC.)

Plastics violate principle 3. 'First plastic waste contributes to growing dumpsites that destroy potentially biologically productive green areas. Second, the leaching of chemicals from the plastic waste threatens growing plants at the site and along waterways from the area. Third, the extraction of crude oil causes ecosystem damage.'

With principle 4, it is arguable that plastic production is not energy intensive (see Chapter 13). However, they are often used in wasteful ways, as short-life products created to be waste.

A number of corporations in Sweden and Scandinavia, such as IKEA, Electrolux, Nike, the much-maligned McDonalds, and some 40 municipalities have incorporated Dr Robert's four principles into their working practices. The Natural Step has also spread to countries such as Poland and Australia.

Dr Robert commends bio-based materials as the only natural and sustainable base of future material needs. 'Plant cells are the engines for creating value in the biosphere since only they can oppose the tide of constant decay by using energy from the sun.'

Guiding philosophy of The Natural Step

'Presentations of the consensus knowledge can start with the living cell, which is our common link to each other and to the rest of nature. Plant cells are the engines of production in the biosphere and the foundation of our economic activities. Concentrating and structuring matter into useful forms produces material value. Yet due to the law of nature that 'everything disperses' (the 2nd law of thermodynamics) all productive activities will always cause greater disruption elsewhere. Plant cells are the engines for creating value in the biosphere since only they can oppose the tide of constant decay by using energy from the sun. The other law of nature, 'nothing disappears' (the law of conservation of matter), shows how every atom has two choices: it either becomes new resources or accumulating junk.

Over the past three and a half billion years living cells have processed matter into natural cycles transforming the original toxic stew into a clean, diverse biosphere. However, for the last hundred or so years human societies have been processing resources in a linear direction, into visible and molecular rubbish which is accumulating. This is evolution in reverse. Adapting our societies to cyclical processes is a non-negotiable requirement if we want to keep our health and prosperity.' [17, Robert]

Natural Capitalism

Where Natural Steps offers guidelines, Natural Capitalism proposed by Hawkens, Lovins and Lovins, is more prescriptive. Drawing on Schumacher in 1973, they trace the root of the problem to the *lack of value* we give to our natural capital – the earth's resources. 'Capitalism, as practised, is a financially profitable, non-sustainable, aberration in human development. What might be called 'industrial capitalism' does not conform to its own accounting principles. It liquidates its capital and calls it income. It neglects to assign any value to the largest stocks of capital it employs – the natural resources and living systems, as well as the social and cultural systems that are the basis of human capital.' [14, Hawken]

In the present industrial model the creation of value is portrayed as a linear sequence of extraction, production and distribution:

> 'Raw materials are introduced (enter nature, stage left). Labour uses technologies to transform these products which are sold to create profits. The waste from production processes and the products themselves are disposed of somewhere else (exit waste, stage right). However, the planet is not growing, so the somewheres and elsewheres are always with us. The increasing removal of resources, their transport and use, and their replacement with waste steadily erodes our stock of natural capital.'

As a system, it is a very ineffective way of producing goods. 'Only 1% of today's resource flow actually ends up in durable products. Today's cars use only 1% of their fuel energy to move the driver. Ordinary light-bulbs turn only 3% of power plant fuel into light. The US economy wastes at least US$300bn worth of energy every year: despite past savings approaching US$200bn a year, it's less than one-tenth as energy-efficient as the laws of physics permit.[220, Lovins]

Since the wheels of the industrial revolution started turning, a new pattern of scarcity is emerging. Where once there were too few people and abundant resources, there are now many people and too few natural resources. What Hawkins and Lovins propose is a system that recifies this imbalance and puts value on all forms of capital, including human. 'To enable countries, companies and communities to operate by behaving as if all forms of capital were valued' requires a radical change in the way we use our resources and deal with our wastes. They propose four central strategies.

1. *Radical resource productivity* is the more effective use of resources to bring three significant benefits. Resource depletion is slowed down at one end of the chain, pollution reduced at the other end, and more meaningful employment is created.

2. *Service material flow* is a method of reducing material flow. It questions how *material* the need is, and proposes a service rather than a material solution and introduces new ways of considering ownership and responsibility for material goods.

3. *'Biomimicry'* emphasises the importance of learning from and preserving nature. Reducing the wasteful throughput of materials – indeed, eliminating the idea of waste – can be accomplished by redesigning industrial systems on biological lines, to enable the constant reuse of materials in closed loop cycles.

4. *'Investing in natural capital'* i.e. renewable bio-based material. 'Reinvestment is necessary in sustaining, restoring and expanding stocks of natural capital, so that the biosphere can produce more abundant ecosystem services and natural resources.' [14, Hawken]

Factor of 10 and beyond

Since the mid-1990s ecologists, some governments and international institutions have set out to reduce by at least a factor of 10 the speed at which we consume resources. Two key strategies employed that relate particularly to plastics are improving material efficiency (a similar concept to radical resource productivity) and moving from product-based economies to service-based systems.

Improving material efficiency

Improving material efficiency aims to reduce the virgin material throughput. At its simplest it means 'obtaining the same amount of utility or work from a product or process while using less material and energy'. Hawken and Lovins suggest several ways to increase efficiency, which often overlap and reinforce each other: more flexible management, better design, more effective controls of production systems, finding ways of saving materials, as well as inventing new processes and technologies.

Better design is the starting point, the corner stone of any material development. It requires improving not only the design of a specific component but of the entire product or process that uses it. Design should not be 'the art of compromise' but of finding ways to optimise the entire system being designed; because optimising the components of a design in isolation from each other tends to weaken the entire system.

Re-thinking conventional manufacturing processes can save materials by improving production quality, and increasing the value of our products and services per unit of natural resources used. For example, eliminating waste scrap can take many forms. Computer

graphic programmes can design complex cloth cutting patterns that minimise wastage. Three-dimensional lasers can visualise how best to saw up logs to use the least amount of timber for specific wood products. Another way of saving materials is in the efficiency with which the raw material is converted into the finished object. Excess material needn't be removed to achieve a desired shape if all the material is manufactured in the desired shape. Instead of using many machined or cast parts, some products (Hawken and Lovins use the examples of toilet float/valves, steel tricycles and car windshield wipers) can be moulded from metals, clays or plastics into single or fewer parts.

Durability

Extending the useful life of products will reduce the use of resources. The material chosen must be appropriate to the function of the product life – its use *and* disposal. Persistent and durable materials, particularly plastics, are often used where the product has a short use-life or is meant for disposal which leads to large volumes of non-biodegradable solid waste, for example, disposable cups, bags, bottles, or throwaway packaging made of polystyrene and other durable polymers. Clearly, it would be better to use materials that biodegrade without hazardous consequences, for example, renewable materials such as jute and coir or bio-plastics or composites made f rom bio-plastics and traditional materials.

Long-life products should be built for durability and repair (incidentally an India tradition with the venerable Ambassador car). This obviously reduces the virgin material resource flow, for consumer durables such as cars, washing machines, televisions, refrigerators etc.

Repair and recycling

Products can be designed for recycling, both in the material used and in the modular structure of assembling the product. In long-life products components made of different materials can be more easily disassembled into their constituent material parts and recycled or replaced. Modular product manufacture designed for recycling is increasingly becoming standard practice with many manufacturers in the north. The European Union is encouraging this process by means of take-back regulations initially now being applied to cars and electronic products, both with substantial plastic components (see

Chapter 14). Products that are returned to the manufacturer for continuous repair, reuse, and re-manufacturing, is a process that Swiss industry analyst, Walter Stahel has called 'cradle-to-cradle'. Table 23 gives examples, including ways of increasing resource efficiency.

Hawkins and Lovins believe that combining all these various steps – 'product effectiveness and longevity, minimum-materials design and manufacturing, scrap recovery, reuse, re-manufacturing, recycling, and materials savings through better quality, greater product effectiveness, and smarter design' – would reduce the total flow of materials by a factor much nearer to 100 than to 10.

From goods to services

A key strategy to reduce material throughput is changing the base of our economy from one of provision of material goods to one of service provision. The architects of this industrial model are Walter Stahel and German chemist Michael Braungart. It is also one of Hawken and Lovin's four central strategies called *service and flow.*

Rather than the material product being the central transaction, it is the service it offers that is bought and sold. Consumers obtain services by leasing or renting goods rather than buying them. (This concept of service should not be confused with the usual meaning of the 'service economy', where industries such as financial services often encourage greater consumption of materials.)

In this service economy the product is a means, not an end. Retailers and manufacturers cease thinking of themselves as *sellers of products* and become *deliverers of service.* Their goal is selling performance and satisfaction rather than equipment, although the service could mean the provision of long-lasting, up-gradable, and durable material goods. Because the product remains the property of the service provider, the latter would be responsible for its repair or replacement and therefore would provide the most efficient hardware. This concept could be applied to computers, cars, refrigerators, washing machines (all with large plastic components), and almost every other durable product that people now buy, use-up, and ultimately throw away.

Table 23 Resource efficiency and business strategies in the service economy

	Closing material loops Technical strategies	**Closing liability loops Commercial/marketing strategies**
Increased Resource Efficiency	Eco Products - Smaller and lighter goods e.g. computers, cameras - Multifunctional goods e.g. combined telephone/fax/copier - Standardisation of goods and components e.g. standard (glass) re-fillable beverage containers	Eco Marketing - Shared utilisation of goods e.g. Laundromat, public toilet - Selling utilisation instead of goods e.g. leasing of photocopies, construction equipment, apartments
Reducing the SPEED of the Resource Flow	Re-manufacturing - Long life goods e.g. stone built houses - Product life-extension by re-use and repair e.g. upgrading computers - Product-life extension of components e.g. refillable toner cartridges, rags for paper production	Re-marketing - new products from non-hazardous waste e.g. compost - Product life extension into new fields (reincarnation of old products) e.g. dismantling of computers and re-sale of components
Reducing VOLUME and SPEED of the Resource Flow	System solution e.g. longer roof designs to protect timber window frames e.g. energy efficient house design preventing the need for air conditioners	Systemic solutions - Selling results instead of goods e.g. pest and weed-free fields instead of agrochemicals, outsourcing - Selling services instead of goods e.g. desktop publishing instead of software

Source: Adapted from Stahel Walter, R. The Product Life Institute, Geneva 1994

Personal computers are an obvious example. For example, the services we require from the PC include the ability to store and manage data and connection to the Internet. In our present model, as technology develops and makes our previous components obsolete we are required to buy bigger specification machines (encased in plastics) with more capacity and memory, and software that is upgraded as soon as we've bought it. In a service economy, hardware and software could be leased, space could be communally shared over electronic networks, and software distributed electronically (rather than on polycarbonate plastic disks).

Microsoft and Sun Microsystems - Material and Service

The Microsoft inspired strategy is of a personal computer on everyone's desktop, and every one a miniaturised mainframe with software duplicated in every machine. Hardware and software are upgraded regularly to ensure 'turnover' for both hardware manufacturers and software designers. The Sun strategy, on the other hand, sees itself as the ultimate computer, with the software built into the centralised infrastructure, like telephony. 'The gurus at Sun foresee a world in which everything – automobiles, electric shaves, lawnmowers – is connected and feeding off the web, which is less network, than virtual machine.' [221, Sutherland]

The electronic distribution of software and leasing of hardware is still profitable for the originator, and the re-seller. In the existing system of 'box shifting' individual computers, there is no incentive for hardware producers to design their products for minimal material throughput. On the contrary, the more hardware they sell, the more material they throughput, the more profit they make.

This service system, for computers as well as many other products, discourages material throughput and inevitably reduces the burden on resources. In order to maximise the value of their assets manufacturers will use fewer materials. They will maximise product durability and ease of maintenance, including designing for repair and recycling. Producer and customer would share an incentive to form a relationship that continuously anticipates and meets the customer's evolving needs, altogether a more satisfying arrangement.

To those unfamiliar with the service economy concept, Walter Stahel often uses the example of a camera. If a person is asked which of two cameras is the most environmentally harmful, a

precision, hand-made, metal camera such as a Nikon or Leica, or a cheap plastic camera, they would almost certainly say the latter. Wrong, says Stahel. The expensive hand-made camera uses more resources in its manufacture. Often extra lenses and ancillary equipment are bought and rarely used. What we want is not the camera but the service – photographs. The cheap plastic camera comes with a film inside. Once exposed, the film and camera are returned to the shop. The shop develops the film and then reloads the camera with film for the next customer. We buy the service, the photographs, and not the camera. The camera, although probably made of unsustainable and possibly hazardous plastic, is reused constantly. The plastic casing could, of course, be made of bio-plastics. Recently technology has replaced film in cameras with digital chips. This means that no hazardous chemicals are needed for processing. Not only that but also the digital image need not be printed and can be distributed electronically, thus further reducing material usage.

Preserving capitalism

Hawken and Lovins quote Einstein's dictum that problems can't be solved within the mind-set that created them. They analyse the mental model that forms the basis of present economic thinking and outline the possibility of a very different mind-set and set of values to form the basis of 'Natural Capitalism'. Yet they too are conditioned by their culture and society. Business, according to the old adage, has always been the business of the US, the homeland of Hawkins and Lovins.

Improving material efficiency and moving from a material to a service economy is essentially a way of preserving the present capitalist status quo, while reducing material throughput. Through more efficient design and better technologies industry will be able to provide the same goods and services. In this scenario the reformed corporation will be the new paradigm: lean-thinking, non-waste generating companies; those who invest in and control new technologies and design concepts, patent bio-technologies, or an effective fuel-cell car, and successfully market their services. Three-dimensional lasers, fuzzy logic control systems and such like will require capital for development, they will be controlled and patented. Only large companies and the multi-nationals have the

capital to invest in these new information-based technologies and have the potential markets to payback such expenditure. (Toyota, Dow Chemical Company and Shell are amongst those mentioned by Hawkens and Lovins as practitioners of Natural Capitalism.) The new paradigm remains 'a business opportunity' and the successful will be those that grow, (and inevitably use more resources).

Even if such measures extend our use of our finite resources, there will still come a point in the not so distant future when essential minerals, including the oil for plastics, will run out or we agree to stop using fossil fuels because of the environmental damage being caused. Therefore, we must look again at the ecological processes that regenerate nature, and at the requirements of the huge numbers of people that are not being satisfied through market mechanisms. Look again at how we view the resources we have inherited, and which we now threaten. And realise, that in the not-too-distant future our material needs will have to be met by *renewable* materials, and not from our fast emptying store of finite resources.

16 Renewable materials and bio-plastics

'If we accept finite raw materials as necessary we have already accepted that we will all die together in poverty.'

Dr Karl-Henrik Robert, Sweden, 1996

In the US Hawkins and Lovins have found that even large MNCs are switching to imitating biological and ecosystem processes replicating nature's cyclic methods of production 'emulating nature's life-temperatures, low-pressure, solar-powered assembly techniques'. [14, Hawken]

In tandem, over the last decade, a number of conferences and symposia have taken place on the theme of sustainable product development. Academics, eco-designers, intermediate technologists, and sustainable product developers are looking at ways to provide for material needs using low-invasive, culturally sensitive mechanisms and technologies, and renewable materials. These developments often take place outside mainstream corporate research and development and are not solely motivated by return on capital invested. They work within existing social contexts rather than try to protect the future of capitalism. Technologies are mostly designed for rural, bio-based economies, mainly in the south. Consideration is given to how *appropriate* they are for specific communities. NGOs and villagers contribute ideas. Designs and technologies are freely exchanged, not patented and controlled.

Sustainable product developers look for ways to introduce environmental parameters such as energy efficiency, non-toxicity and

recyclability into small-scale production systems. They consider wider socio-economic concerns such as preservation of diversity and using renewable rather than finite materials. Since each country has specific renewable materials, the material composition and design of products that provide a similar service will vary from place to place. In the Netherlands, Proterra has described existing market requirements, which could be met by products from renewable resources (see Table 24).

Table 24 Potential markets for renewable resources

Markets	Product Examples
Packaging Disposables	Organic waste disposal bags, disposable crockery, cups, snack trays, loose fill, trays, diapers, shampoo-bottles
Automotive Industry	Floor-covering, upholstery, carrying parts, side panels, dash board, cushions, sound-isolation, fibre fortified bumpers
Paper industry	High-value writing paper, tea bags, coffee filters, artist's paper and non-woven disposables
Sports goods	Surf-boards, golf-tee, clay pigeon, hockey-sticks, tennis rackets, components of race-cars
Building materials	Insulation material, natural fibre plates for container floor, composites, plates for ceiling and construction, window and door frames
Geo-textile	Woven and non-woven geo-textiles
Furniture and interior	Chairs, tables, bowls, vases, cupboards, upholstery,
Controlled release	Agriculture, horticulture, medical
Absorbents and filters	Quilt, diapers, filters, oil-absorbents, airco-filters, sanitary towels
Horticulture	Clips, hooks, biodegradable strings, compost bag, foils and nets, agricultural plastic
Other	Housing for equipment, goods, profiles, coachwork, and promotional gifts.

Source: © Proterra

There are a number of 'sustainable' products being developed by the United Nations Environment Programmes Working Group on Sustainable Product Development (UNEP WGSPD). This is a group of engineers, scientists, and product designers who work both in the north and south. [222, Tromp] [9]

Traditional plant-based materials are increasingly being used for construction and textile applications, including the major fibre crops such as cotton, jute and jute-like materials (for example, kenaf), flax and sisal. Other crops and fibres such as ramie, kapok, coir and especially hemp are regaining popularity. India has an abundance of many of these materials. They can be used in innovative ways, for example, as 'geo-textiles' to protect soils, embankments and riverbanks against erosion. And they can replace current oil-based plastic polymers.

Moser's Eco-tech

Austrian academic, Dr Anton Moser, predicts that our current economies, built on the use of hydrocarbons, will inevitably be replaced by the marriage of advanced technologies to renewable bio-materials. He claims that 'the carbohydrate economy will be the next industrial revolution through eco-technology'. He has devised a series of sustainable 'eco-principles', based on the structure and mechanisms of nature, called Principia Ecologica. [223, Moser]

According to Moser, bio-technology will replace the current chemical technology for industrial production. Table 25 lists ecologically sustainable technologies that can provide necessary goods and services, all involving the 'biologicalisation' of technology. For plastics, bio-polymers are the only sustainable substitute for current fossil fuel and industrial chemical based plastics.

The feedstocks for these new products are the renewable materials from the earth's bio-mass – woods, grasses, farmed crops and ocean sources. Dr A.J. Varma from the National Chemical Laboratory in Pune, India, speaking at the BIOplastic Conference, in Bonn, Germany, in 1999, described the enormous potential for replacing oil-based plastics with materials made from naturally occurring bio-polymers:

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[9] A current list of reports and sustainable products can be found on the UNEP WGSPD web site. http://unep.frw.uva.nl or by post from UNEP-WG-SPD International Centre, 3rd Floor, J.H. van't Hoff Institute, Building 'B', Nieuwe Achtergracht 166, 1018 WV Amsterdam, Netherlands.

Moser's Principia Ecologica

For many centuries western society has strictly followed the 'reductionistic view', an approach which can be seen as an attempt to reduce complexity by discovering the component parts and their interactions. The laws of physics governed all phenomena. Moser, and many scientists and thinkers today, influenced by new developments in quantum physics etc, have rejected this model. They argue that a simple causal nexus can not be posited in complex situations. A new 'systems' approach is needed.

Moser's 'eco-principles' emphasise holism. The principles have to be innately flexible – like nature itself. The more dynamic the state of the organism, the greater its ability to adapt to changing environmental conditions. Prerequisites are the diversity of nature, the complex interdependence of species and the need for renewability of mass (material) flows.

Moser advocates mechanisms to achieve the eco-principles. He calls these 'Eco-tech' or 'Ecological Process Engineering'. Eco-tech uses bio-diversity in a holistic and low-invasive way through efficient engineering to enhance the welfare of humankind. This means balancing input and output from the natural world, using the available fertility and assimilative capacity of soil so as not to damage local fertility. This precludes using genetically manipulated organisms. [223, Moser]

Table 25 Case studies of 'eco-tech' bio-processes

Bio-fertiliser	agriculture and forestry
Bio-polymers	packaging / short and long life products
Bio-insecticides, herbicides, fungicides	agriculture and forestry
Bio-drugs, bio-prophylactics, bio-diagnostics	health care
Bio-leaching	mining, detoxification of soil and water
Enzyme technology	pulp and paper, bio-catalysis, bio-transformations, bio-organic chemistry
Bio-detergents	washing powders
Bio-denitrification	drinking water, waste water
Bio-depesticidation	drinking water, waste water
Bio-dehairing, bio-defattening	leather and meat industry
Bio-fuel	mobility
Bio-remediation	soil recovery
Bio-flavors, bio-odours	food and fragrances
Bio-villages	local communities
Indigenous techniques	sustainable technologies
Traditional wisdom	harmony with ecosystem

Source: Moser 1995 Principia Ecologica

'The world crude oil production is 3 billion tonnes per annum, made with the help of polluting industries. In contrast, nature utilises carbon in photosynthetic bio-mass production equivalent to 40 billion tonnes, with no pollution effects. World production of all synthetic polymers put together is 150 million tonnes per annum. Approximately 150 billion tonnes of lignocellulosic matter in the form of renewable vegetation is produced each year on the surface of planet earth, and represents the most abundant bio-polymer available. If we could innovate and use 1% of annual renewable polymers without disturbing earth's ecology, it would represent about 1,500 million tonnes of polymeric material, ten times more than all the synthetic polymers put together. Still 95% of world plastics are based on non-renewable resources! Every kilogram of natural polymer that replaces a kilogram of synthetic polymer contributes to the cause of the environment. This is food for thought for policy makers as well as those who provide funds for research and development in academia as well as for industry.' [116, Varma]

Sources of bio-materials

Chitin, an animal polysaccharide, is the second most abundant bio-polymer, available from ocean sources (crab shells, squid, krill, shell-fish, clams and oysters, etc. contain chitin). There are a variety of industrial polysaccharides available, many of them like tamarind ker-nel polysaccharide are cheap sources of complex polymer materials that can be developed for speciality applications. There is potential for 60 million tonnes of lignin availability from pulp and paper mills itself. These are complex multi-functional aromatic-aliphatic polymers that have always fascinated chemists. A variety of proteins are available. Collagen is the single most abundant protein (30% of all protein) present in mammals in the form of fibres, and has great potential for further applications development. Millions of tonnes of table sugar are produced each year and the production can easily be increased if its usefulness in bio-plastics is proved.' [116, Varma]

Bio-plastics

The new generation of plastics, bio-plastics, can be made from a number of renewable bio-based sources including starch, sugar, cellulose, proteins, oils and fats. (The term 'bio-polymers', sometimes used interchangeably with bio-plastics, is a misnomer. All bio-based materials, namely agro-fibres, starch, hair and horn are made of bio-polymers: indeed, humans are made up of bio-polymers.)

> 'The physical properties of natural fibres have several advantages over synthetic fibres as reinforcing agents for use in high value composite materials. In this context it should be remembered that there are trees (natural composites) that have survived for thousands of years completely exposed to the natural environment, which possibly no other synthetic material can accomplish.' [116, Varma]

The first so-called biodegradable plastics came on the market at the beginning of the 1980s. 'They were cheating, a trick, because they were made from chemical modified PE or blends from PE and starch. While composting only the biological degradable components were degraded, so the desired optical impression was given. In fact the biodegradation of the synthetic compounds failed.' [224, Steinbuchel] These materials, with their misleading claims, created confusion for the nascent bio-plastics market.

The second generation of biodegradable materials was developed in the middle of the 1980s. They were made from thermoplastic starches or from blends of starches with synthetic polymers such as polycaprolactone or polyvinylalcohol. Most of these materials achieved the demands of biodegradation or composting, but their material properties could not compete with the properties of oil-based plastics.

The third generation of bio-plastics was produced by fermentation. These polymers, for example, polylactic acid (PLA) or polyhydroxy fatty acid (PHA), achieved the mechanical and processing properties of oil-based plastics together with good biodegradability.

Table 26 Natural and synthetic categorisation of bio-plastics

Naturally Occurring Polymers	Polysaccharides / polyglucose	Neutral: cellulose, chitin, starch, galactomannans; acidic: plant exudates, gum arabic, alginates; fermentation: pullulan, dextran, xanthan; derived polymers : carboxymethylcellulose, hydroxyethylcellulose, cellulose acetate, starch ethers, dextrins
	Agriculture lignocellulosic fibre polymers Agricultural lignocellulosic residues	Cotton, jute, sisal, flax, hibiscus, pineapple leaves, banana, date palm, coir Rice, wheat, and cereal, sugarcane bagasse
	Polymers from bio-organisms (polyesters)	Polyhydroxyalkanoates (PHA)
	Proteins	Collagen, casein, albumin, silk, feather, keratin
	Naturally occurring polymerizable monomers Agricultural monomers	Sugars, castor oil, other vegetable oils, cashew nut shell liquid, natural rubber, shellac, terpenes
	Monomers by fermentation of sugars	Lactic acid
Synthetic polymer bio-plastics		Aliphatic polyesters, poly(ether-esters), poly(amide-esters), poly(vinyl esters), poly(ester-urethanes), poly(aspartic acid), poly(phosphazenes), Poly(vinyl alcohol), poly(e)carprolactone (PCL), starch blends

Source [116, Varma]

Composition of bio-plastics

Bio-plastics are made by taking the building blocks of the complex carbohydrates that make up plants and ocean materials and reconstructing (polymerising) them into plastics, either chemically, thermally or biologically, using micro-organisms.

The degradation of the polymer may be caused by naturally occurring micro-organisms, the assistance of UV and heat radiation from sunlight, hydrolysis by water, oxidation by air, and so on.

Table 26 gives a breakdown of the main natural and synthetic bio-plastics currently being researched and their base material. Of these there are four main types of bio-plastics currently in the market:

- Thermoplastic starch
- Cellulose acetates
- Polyhydroxyalkanoates or polyhydroxy fatty acid (PHA)
- Polylactides, for example, PLA

Of these, thermoplastic starch and PHAs are acceptable non-hazardous alternatives to petroleum-based plastics. Not all bio-plastics are environmentally sound. Some require chemical modifications or metal catalysts in their production processes. And all bio-based technologies must be seen within a wider definition of 'sustainability'. This means addressing the control of technologies and resources, and avoiding creating further ecological problems, for example, by using Genetically Engineered Organisms (GEOs) to manufacture bio-plastics. The composition of starch produced by potatoes, maize and wheat is being altered, via genetic engineering, to make it more suitable for 'designer' thermoplastic starches.

Although bio-technology offers a route to sustainability, it can potentially be even more destructive than today's use of synthetic and toxic chemicals. Genetic engineering generates a much faster rate of change, and the construction of organisms is optimised according to narrow, short-term market criteria. It aims to remove biochemical barriers between species, thus breaking down geographical barriers and accelerating the destruction of indigenous ecosystems. These aims fundamentally contradict the framework of an 'error-friendly' evolution, especially for more complex and long-lived species, like humans and most of their domesticated plants and animals. (Christine von Weiszaecker, Vice-Chair of Advisory Board of German Consumer Testing Foundation).

According to Anton Moser, gene-manipulating bio-technologies probably do not fulfil the eco-principles because their holistic effects and synergistic interactions are unknown. A GEO is acceptable and safe only if it is:

- non-pathogenic to plants
- non-pathogenic to animals

- the bacteria could be derived from that used for human beings
- unable to reproduce in the open environment, including delayed reproduction of survival forms
- unable to alter irreversibly the equilibrium of natural populations
- unable to transfer genetic traits, in the open environment, which would be noxious to other species.

(From the workshop on Biotechnology and The Natural Step, held during Fourth European Roundtable on Cleaner Production November 1997, Oslo, Norway)

Current bio-plastic applications

'Application of polymers from renewable recourses – so called biopolymers – has a large potential market due to the current emphasis on sustainable technology', declares the International Centre of Biopolymer Technology (ICBT). However 'eco-friendly' the material is, the product applications for bio-plastics, like any material, will depend largely upon its material properties, for example, strength, life-span, resistance to heat and water etc.

The current market for bio-plastic products is mainly for limited or finite-life products, particularly for products created to become waste, like packaging and compostable bags. According to Fardem in Belgium, (originally a family owned company dealing in jute bags, then as part of DSM an important supplier of polyethylene, Fardem has been through the material loops), the market for compostable bags is developing very fast, and many communities in different countries are using bio-plastic bags for the separate collection of organic waste. Other products in the market today include: packaging, credit cards, beverage cups, bottles, cutlery, flower pots, golf tees, pens, trash bags, food containers, picnic plates, soda bottles and drink lids, ropes and fabrics, microwave dishes, ground-stabilising nets, pen casings, insulation. [226, Royal Society] [227, CEAM]

Biodegradable bio-plastic clearly has many advantages for 'single-use disposals', from packaging food to hazardous medicine. In both cases the organic bio-plastic waste is easily dealt with by composting or burning. For holding hazardous material (medical syringes, gloves etc), bio-plastics could be safely incinerated without hazardous emissions or landfilled with complete biodegradability.

However, as Dr Varma said, 'We have to think beyond the use of short-life applications. There is very great scope for developing construction materials and relatively long-life goods with the use of natural waste polymer materials. They too will have to be disposed of at some stage. The key is good chemistry using low energy, consuming environment-friendly processes'. [116, Varma] US giant tyre manufacturer, Goodyear has developed a new filler based on starch for its tyre compounds. According to Goodyear, this bio-plastic material is ecologically sound and improves performance in a number of ways. What is less certain is whether bio-plastic technology can replace all oil-based plastic materials used in high-tech applications such as engineering and aerospace.

Bio-fillers in tyres

'The use of starch based bio-fillers represents a technical breakthrough in tyre technology, overcoming the concept of biodegradability to focus more on overall environmental impact. Tyre tread formulations have been developed by replacing partially carbon black or silica with starch derived fillers as reinforcement. It provides significant reduction in tyre rolling resistance combined with improved performances on wet roads. The starch filler helps to reduce tyre weight and offers wear resistance equal to current energy-saving silica tyres.' According to Goodyear calculations, the new tyres with bio-fillers can offer a significant contribution to the reduction of $C0_2$ emissions into the atmosphere, reaching about 20% of the target established by the European Commission and the car industry for year 2008. [228, Corvasce]

Table 27 New markets for bio-plastics

Industry	Product incorporating bio-plastic material
Chemical industry	Additives, glues, solvents, lubricants, detergents, coatings
Energy	Gasification and combustion installations
Packaging and disposables	Waste bags, cutlery, foils, diapers, bottles, coatings, filters, telephone cards, nets, cloths etc.
Paper industry	Paper for value documents, tea bags, newspapers, non-woven disposables, fluff for hygienic products etc.
Building materials	Insulation materials, composites for profiles and plates, door and window frames, plinths etc.
Controlled release Horticulture	Applications in medication, horticulture, agriculture. Clips, rope, foils, substrates, labels etc.
Automotive industry	Floor covering, pillows, panels, thermal and sound insulation, upholstery etc.

Source: © Proterra, International Centre for Agro-based materials, phone: +31 317 467 661

From waste to product

The raw material for bio-plastics could either be purposely grown crop/starch or current biological wastes. From being a problem that, in the north, a waste treater is paid to remove, the waste becomes a resource, the raw material for a bio-plastic producer. The waste treater could source and deliver the biological material to the bio-plastic production facility. Proterra believes that these developments will result in new economic structures in existing and new markets, and in different ways of dealing with products and services.

In the north the amount of plastic packaging in waste-streams has become a big disposal problem. Food industry packaging and service-ware in the waste stream contains significant quantities of food that with oil-based plastic is virtually unusable but with bio-plastic packaging could be constructively used as a good fertiliser base.

> 'We can generate much-needed carbon-rich compost (humic material) by composting our biodegradable plastic and paper waste along with other organic compostable materials like food and agricultural wastes. Compost amended soil has beneficial effects by increasing soil organic carbon, increasing water and

> nutrient retention, reducing chemical inputs, and suppressing plant diseases. This concept is important for sustainable agriculture practices.' [229, Narayan]

Directives and labelling to explain the biodegradable nature of the bio-plastic material are vital for these processes to work. With the introduction of non-biodegradable bio-plastics that mixed conventional plastics with starch, the need for standards to control waste-streams became imperative. Basically four characteristics of the packaging need to be evaluated: biodegradability of individual packaging components; disintegration of the complete packaging during biological treatment; effect on the biological treatment process; and effect on the quality of the resulting compost. [230, Van de Zee et al]

The family of PHAs (polyhydroxy alkonate)

The family of PHAs are polyester bio-plastics, produced by bacterial fermentation. They have a number of performance attributes which set them apart from conventional materials. The properties range from stiff, highly crystalline materials like PHB, to rubbery elastomers like polyhydroxyoctanoate (PHO) to other PHAs that are completely amorphous, tacky substances. PHB, polyhydroxybutyrate, was the first of the family to be discovered and is the most abundant of PHA's in nature. It is prepared by a bacterial fermentation process using a variety of feed stocks including glucose, molasses, acetic acid, fatty acids, etc, and is a highly crystalline thermoplastic sharing many properties with polypropylene (PP). The material properties of PHB are excellent: it is water-resistant and is the only biodegradable polymer resistant to heat above 120 degrees centigrade, which makes it suitable for microwave fast food service ware. It is suitable for waterproof coatings, films, wrappings, biodegradable carrier for long term dosage of herbicides, insecticides or fertiliser, blood vessel and bone replacement, wound dressing, surgical pins, sutures, staples and swabs. [231, Leipzig] Because pure PHB is brittle, most products on the market are co-polymers of PHB and other PHAs such as PHV (polyhydroxyvalerate) referred to as PHBV. [230, Van de Zee]

PHB

The French microbiologist, Maurice Lemoigne first identified PHB in 1925. However it was not until 1990 that it arrived on the open market with the brand name Biopol, developed by ICI in the UK. Zeneca (formed from an ICI demerger) further developed the material before selling to Monsanto in 1996. With Monsanto, Biopol received wide press coverage in part through the innovation of the first biodegradable credit card, a collaboration with Greenpeace, and also because of the success of the Wella 'Sanara' shampoo bottle. Monsanto, having failed to find a strategic alliance or investment partner for future development of Biopol, have sold their interest in Biopol.

Proterra estimates the market potential for PHB to be about 100,000 tonnes or 20% of the biodegradable, disposable and packaging and horticulture markets. However, it will only increase its market share 'once the price is reduced to at least US$3 per kilo, and then the long-term opportunities for PHB could be as much as one million tonnes annually'. [232, Proterra]

Currently the production of PHA by bacterial fermentation together with the extraction and purification process, makes PHA very expensive – it is about ten times more expensive than petrochemical polymers of comparable properties. Therefore it is certainly not suited for low-value commodity products, and research organisations are looking into bio-technological methods of production to enhance its margins. A few commercial companies are studying 'the transfer of genes from bacteria to plants and developments to get higher yields. They have aroused great interest, and have a promising future'. [116, Varma].

Northern market for bio-plastics

The bio-plastics industry today is in its infancy. Professor Jeremy Sanders of the University Chemical Laboratory in Cambridge, UK, says, 'At the moment there is no real bulk market and there will not be bulk market until the price of oil goes up markedly'.

> 'Starch is certainly not able to compete with petrochemicals for the plastics, surfactant and paint industries on purely economic terms at present. However, increases in the price of oil, the finite supply of this commodity, improvements in starch-based

products and increasing consumer demand for 'green' products would all favour starch over petrochemicals in future.' [226, Royal Society]

In 1996 the total demand for bio-plastics in the US, Western Europe and Japan reached 14,000 tonnes valued at over US$70 million. Total consumption in these three regions is expected to increase to about 70,000 tonnes in 2001, representing an average annual growth rate of over 35% in the period 1996-2001. [232, Proterra] [10]

Professor A. Steinbuchel, chairman of the BIOplastic conference, in Bonn Germany 1999, is more pessimistic about short-term production and consumption. 'At the beginning of the 1990s, the European market potential was estimated to be more than 1.1 million tonnes. In 1997, however, the combined European and North American markets were estimated much lower at more than 20,000 tonnes. Because of a slow increase in consumption, a significant development is not expected within the next few years. A recent study from Frost & Sullivan forecasts a European market of 24,000 tonnes by 2004.' [224, Steinbuchel]

Bottlenecks in the market

Introducing a new technology that is not only a material, but also embraces a whole life cycle, involves a complex re-organisation of company structures and perceptions. There are a number of factors that impede its adoption.

Crucially all bio-polymers are *relatively expensive* compared to synthetic oil based plastics. As with any innovative technology, there are high research and development costs. Until quality improves, further applications are developed and volumes increase, this price bias will continue to exist. Current developments of biopolymers are mainly financed by subsidies, and most analysts predict that these will 'have to continue as long as there is no considerable scaling up of the production (less than 100,000 tonnes).' [233, Proterra]

- There are some technical uncertainties within companies concerning the *right choice of material* (for example, thermoplastic starch, PLA etc).

[10] In the UK use of starch accounts for only 3% of plastics manufacture [226, Royal Society]

- The *processability* of bio-plastics by standard technologies is still not satisfactory.
- It is difficult for many companies to *integrate biodegradable* materials in their strategic product/market combination.
- The consequences for the *image of the company*, and the trademark in various applications are not clear yet.
- The benefits or drawbacks of genetically modified starch and other raw materials is unresolved.
- *Definitions* of biodegradability and compostability are unresolved. An international standard for degradable materials is being developed, which is vital for the integrity of the bio-organic waste stream to operate successfully. The current European CEN/DIN and North American ASTM norms are still being drafted, or if published, are not yet incorporated into legislation.
- The legal framework for the *utilisation of biodegradable* materials is uncertain – each country in Europe has a different system for the collection of organic wastes at a municipal level. Within waste management, local authorities have not approved bio-polymers as compostable waste. This is partly due to bad experiences in the past with synthetic polymers containing starch being labelled as biodegradable and to lack of familiarity with new developments. [224, Steinbuchel] [233, Proterra]
- Some developments in the market have impeded the fast introduction of biopolymers. In Germany, for instance, '*Grüne Punkt*', the programme for recycling synthetic plastics, created the idea that plastic waste could be successfully managed, so that there was less interest in developing bio-plastics.
- A unique property of bio-plastics is their biodegradability, and this was prioritised as a central marketing strategy. However, it has become clear that biodegradability alone is not a sufficient criteria to replace conventional plastics.

Policies for promoting bio-plastics

Without question the market for bio-polymers will increase as readily available supplies of oil start to dwindle, and the price of oil-based products rises. In the interim the successful introduction of products

based on renewable raw materials will depend on their functional advantage, waste management (creating new structures and ways of dealing with bio-wastes), marketing and legislation.

Bio-degradable material offering unique advantage

In the Netherlands PVC body bags were commonly used for body burial, but owing to the barrier properties of PVC, complete decay of the corpse could not occur within the minimal period of 10 years of grave rest. Changes in Dutch legislation have prescribed that all materials used for human burial must be biodegradable by January 2000, which has promoted bio-plastics in this unusual market. While this is not a relevant market for India, it is an innovative and efficient use of a biodegradable material.

In Europe there is increasing environmental awareness, and a growing market niche for 'sustainable' products. Industry is responding to consumer pressure. Proterra optimistically say it is the success of market applications of bio-plastics that will encourage government policy to promote them, rather than the other way round. 'Changes in market attitude are happening because of the success of the first bio-plastics.' They quote the success of a well-known European producer of yoghurt in a biodegradable cup (Danone), along with that of the biodegradable waste bag, and disposables. [233, Proterra]

Grants towards research, differential taxation on plastic products and other economic instruments could all have a part to play in developing and widening the market for bio-plastics. The Netherlands has introduced the 'whole crop concept', as a way of evaluating the best ways of using all agricultural materials, and has subsidised bio-based materials. The use of renewable raw materials in sustainable building has promoted bio-plastics in the construction sector. Legislation discouraging non-biodegradable material has promoted degradable bio-plastics.

With the birth of any new technology it is vital that information is shared. Various organisations exist which help to exchange information and provide the necessary networking support. In Europe the International Centre of Bio-polymer Technology (ICBT) has been created with support from the European Union to facilitate co-operation and the exchange of scientific knowledge between

industries, universities and other research groups in the field of bio-polymer technology.

Proterra in the Netherlands is an international centre, which promotes the application of renewable resources in durable goods, packaging and disposables. It was founded in 1995 by Jorn Behage, the author of several articles about the market potential and application possibilities of biodegradable polymers and co-author of the book 'Packing with biodegradable polymers'. Proterra is active in market development and market exploitation programs, for example, working on bio-composites for the building industry.

In India the National Chemical Laboratory (NCL), a premier research institute located at Pune, is the centre for polymer research. It is a constituent of the Council of Scientific & Industrial Research (CSIR) of the Government of India. The NCL undertakes industrial contract research, consultancy, collaborative projects, as well research in a diverse range of subjects. Dr. A.J.Varma, one of the senior scientists, is leading a very productive research group researching into natural and biodegradable polymers.

Big Boys go Bio

The big northern petrochemical multinationals, while ruthlessly protecting their current plastic markets, have kept a keen eye on the future and some are now moving into bio-plastics production.

In November 1997 Dow Chemical Company and grain processing giant Cargill announced the formation of a joint venture to develop and market a new generation of bio-plastics made from corn, sugar beets and other agricultural resources. The polymer material they have chosen to develop is polylactic acid (PLA).

MNCs go Bio

'Cargill has built a new plant in Blair, Nebraska, US, to convert grain products into lactic acid, which it will use to produce polylactic acid polymers. The new grain-based plastics can be used in applications such as trash bags, food containers, picnic plates, soda bottles and drink lids. They also can be made in non-biodegradable forms for use in fibres for rope and fabrics.

Cargill Dow Polymers LLC is a joint venture between Cargill and Dow founded in November 1997. (Cargill is an international marketer and processor of agricultural, food, financial and industrial commodities. Dow is the fifth largest chemical company in the world and a major global plastic producer.) The new company will leverage Cargill's expertise and low-cost raw material position with Dow's polymer science expertise to provide a full range of services – from resin development to application development support. Cargill Dow Polymers will manufacture PLA resins at the semi-commercial plant near Minneapolis, Minnesota, USA. The plants current 8 million pound capacity is expected to be doubled by the year 2000. This capacity will be used to create demand for a world-scale production facility, which is anticipated to be built by 2001.

PLA polymers are expected to offer an excellent cost-to-performance balance that will make them competitive with hydrocarbon based resins such as polyethylene (PE), polystyrene (PS), polypropylene (PP) and polyester (PET) in many applications. They offer diverse benefits in extruded and cast and blown film, biaxially oriented film, fibres and non-wovens, paper and board coatings, thermoforming, injections (blow) moulding.' [234, Dartée]

Bio-plastics in India

While there is a theoretical awareness of the potential for biodegradable plastics made from renewable materials, India appears to be investing only in oil-based plastics that have added starch to give them the appearance of biodegradability. In other words the first generation of bio-plastics described earlier. This old technology, dismissed by those currently working to develop bio-plastics, is heralded in India's national press as being state-of-the-art, and 'truly ecological'. As happened in Europe, these false bio-plastics will lead to confusion amongst the general public as well as the ragpickers and those dealing with the waste.

Dr Ravindra Limaye of Gujarat Petrosynthese Ltd recommends bio-degradable plastics particularly for especially for medical, packaging and agricultural uses. 'Considering the growing gap between demand and production technology, research on biodegradable plastics promises to be exciting.' [236, Limaye] Professor Alok R. Ray, from the Centre for Bio-Medical Engineering at the Delhi Institute of Technology, believes that bio-polymer

demand will not come from the shortfall in supplying the plastic market, but from the ready availability of natural bio-polymer material. However, he says, 'Although India has a lot of cellulose products such as cork, straw, grasses and wild leaves there is no funding for research by either government or industry. There is some work being done to develop composite materials with, for example, palm leaves and polypropylene to replace fibre glass but very little research into bio-plastics'.

Indian bio-degradable plastic

'The National Research Development Corporation (NRDC) has developed a 'bio-degradable' plastic by mixing plastic or low-density polyethylene with starch that will soon help bring bio-degradable plastic bags in the market. The projected is developed by Dr S K Nanda of the Central Tuber Crops Research Institute at Thiruvananthapuram, South India.' [235, Hindustan Times]

The time to develop and use materials based on renewable sources is now, a message that seems to have reached India's most astute petrochemical manufacturer, Reliance Industries (RIL). Delivering the 50th Foundation day lecture of the National Chemical Laboratory (NCL), Pune, Vice-Chairman and Managing Director of Reliance Industries, Mukesh Ambani said in January 1999:

> 'In the next century chemical companies will have to switch from making most of their products from 'non-living systems' to 'living systems'. Adopting living systems to make polymers and other materials seems inevitable. It should result in cleaner, more efficient processes and will likely lead to a new class of materials, as well as ways to make use of them.' [237, Times of India]

The irony is that, while the south is seen as the focus of the next bio-based industrial revolution, in countries such as India products made of renewable materials are currently being replaced by oil-based plastics. The commercialisation of products made from renewable materials and transformed by bio-technologies appears to be only developing in the north.

The overriding advantage of bio-based over petrochemical materials is that they are derived from renewable and vastly abundant resources. Furthermore, their production does not harm our atmosphere, nor does their manufacture generate hazardous toxic materials. By their bio-degradability they avoid the production of conventional plastic wastes, and when mixed with conventional organic waste they offer a nutrient rich bio-fertiliser for the land.

Petrochemical complexes are notoriously dirty, energy consumptive, large and culturally neutral. They are dependent on being situated near their required resources – a port if they import, roads and a water system extraction and disposal of waste. For reasons of safety they are isolated from the community they inhabit, and, more often than not, are in conflict with it on account of the pollution they create, the potential for fires or explosion from the chemicals used and the local resources they consume. (Recent legislation in India has attempted to move dirty industries out of urban areas thereby depriving rural communities of land.) A project such as an oil refinery is a 'foreign body depending for most of its life on some other society', as Schumacher said in 1973. [217, Reid]

A shift towards bio-based industries could radically change this structure. The resource base of bio-materials is more diffusely distributed than oil and may be potentially less easily controlled by the corporate world (although northern corporations are already attempting to control the new technology). The production of bio-based materials will require large areas of land but, compared to mining minerals or oil exploration and extraction, the technology of production is not necessarily capital intensive, beyond the high cost of initial research and development. Bio-based products can be manufactured close to the source of raw material, reducing ransport infrastructures etc. All this could change the relationship of communities to their local resources, and their power within the economic structure.

Moser believes that future sustainability lies in the richness of bio-diversity found in the developing world, mostly in the south, including India, where agricultural wastes are abundant and where 74.3% of the population is rural based (1991 census). The south's bio-diversity could form the natural basis of future technological developments such as bio-drugs, bio-plastics etc. He points out that

the countries that support such bio-diversity are normally economically poor in their capacity to use these bio-resources. But the knowledge of indigenous peoples is critical for the understanding of how to use natural ecosystems. Thus 'developing countries' need to be in the forefront of bio-technology development and crucially to build up a critical mass of research and development for the emergence of an indigenous scientific and technical base.

Controlling production systems

Substituting one technology for another based on non-toxic renewable inputs will not, by itself, change the development paradigm. Bio-plastics and products made from renewable resources may address the issues of toxicity and finite oil resources, but bio-plastic is just another manufactured material.

A bio-plastic production facility may be urban-based and its products still threaten artisanal industries. Given the way the emerging bio-plastic industry is structured, control of resources could remain in the hands of corporations, financiers, government and technologists. 'Need' will once again be defined by the producers, to serve the need of industry for markets. Most current markets for bio-plastics products are for 'single-use disposals' – garbage containers, packaging – to solve the waste problems of the growing fast-food industry in the north. Therefore, by its nature, it could encourage a conscience-free consume and throwaway culture. If the emerging bio-plastic market is to succeed, it has to push its production volumes to compete in price against its oil-based competitor. In other words, it has to directly challenge or replace many of the oil-based conventional plastic market, or it has to create new markets. Haven't we heard this somewhere before?

17 Swadeshi and sustainability

'Everybody possesses both materially and morally what they need to design their own society and economy, and can therefore free themselves of oppressive structures.'

Vandana Shiva, The Ecologist, June 1999

Except in isolated pockets societies in the north have lost touch with their immediate natural resource base. Here the most ecologically sound models of human activity, based on *self-sufficiency* and *non-engagement* with the market and corporate culture, are no longer thought feasible or even credible.

Many of the Hawken and Lovins' solutions to improve material efficiency require sophisticated state-of-the art design tools and technologies. The construction of neural networks and fuzzy logic that can continually measure and control industrial processes; three-dimensional lasers that can show how to slice a log and thereby reduce scrapand computer design in clothing factories that can design complex cutting patterns to save wasting cloth. All these technologies are costly and are relevant only for large-scale manufacturing. They are often patented and controlled by MNCs.

Village tailors in India have no need of computer graphic programmes to cut cloth. Their skills have been passed down from generation to generation. The cloth is valued, and value and scarcity are understood. Little is wasted and what is leftover can be used for other purposes. The same applies to artisans working in wood or other bio-materials. Material waste, the symptom of structural

deficiencies in the current northern economic model, has never been a visible feature of Indian village life. That is, until the advent of non-biodegradable plastic.

Sustainability must involve more than new technologies or new ways of structuring businesses such as service industries. Sustainability, as Dr Anton Moser advocates, must be *embedded* into the socio-cultural as well as the economic-organisational structures of diversified but interrelated societies. Any development of eco-technology must therefore involve: 'Economic Efficiency, Ecological Security, Social Solidarity as well as Technical Feasibility.' [223, Moser]

'Eco-tech' in India

Many of the northern radical concepts of 'sustainability' have learnt from, and try to replicate, traditional methods of living (within the bounds of nature). For India, many of the ideas currently outlined in Moser's Eco-Tech, The Natural Step, Natural Capitalism, bio-mimicry and other northern radical ecological thinking are as old as its hills.

In southern countries where labour is plentiful and cheap, relative to goods, the 'service economy' has long prospered. In urban areas of India stallholders on the street do laundry service for middle-class families, eliminating the need for each family to have a washing machine. This saves energy, reduces plastic consumption and provides employment. Because providing a telephone to every household is costly, a community telephone service has developed in India. An ISD/STD booth exists in every village, and on almost every street in Indian cities, providing the community with a telephone service, and, increasingly, Internet access as well. Sharing communication systems also adds to a sense of community (which, of course, is not measurable in conventional GNP terms). Vans with large television screens bring coverage of the Wills World Cup cricket to communities in the local market place. Where 'high-tech' resources are expensive compared to incomes, sharing goods is an obvious option. Ironically most of these communal and age-old services are threatened by the promotion of consumer goods – products for individual ownership that encourage material accumulation and new needs.

Eco-tech has been embedded in Indian culture for generations: bio-drugs (ayurvedic medicine), bio-pesticides (neem), are still an

accepted part of every day life. Bamboo, wood, clay, jute, all these renewable materials and products made from them, have been part of an unofficial sustainable material policy, part of a tradition and local ecology. They are now being marginalised to 'niche' markets, often by the advent of plastic.

Although the fabric of rural society in India is being torn apart by modernity, some village communities have re-established links between their material needs and their immediate ecosystem. These examples show that wellbeing is achievable outside the current industrial economy. The community in Sukhomajri, Haryana, showed how reclaiming responsibility for managing their forests enabled redevelopment of bio-resources and with it prosperity. The same happened in the northeast of Rajasthan, around the village of Gopalpura. Rebuilding traditional irrigation ponds not only provided water for crops, cattle and forests: 'the social fabric of villages has been restored and with it their sense of dignity and purpose... Migration to cities in search of menial jobs and uncertain income ceased to exist as a problem. On the contrary, many of the young have been re-absorbed into the community from the city slums, and have now re-assumed their roles within the community. In a recent Impact Evaluation Study (IES) done in the village of Gopalpura, it emerged that the very notion of 'unemployment' had lost its relevance, there being no person in the village without an important function.' [238, Goldsmith]

Resurrection of ancient conservation in Rajasthan

In the drought-stricken region in and around the Sariska Tiger Reserve in the north-east of Rajasthan a dedicated NGO, Tarun Bharat Sangh (TBS), has been working since 1986 with villagers to rebuild johads - simple and traditional ponds for irrigating, channelling and storing water. According to Zac Goldsmith this has transformed the lives of many villagers in this area. 'Yields of maize, wheat and mustard among others were increased by a factor of 4 to 10 times. Cattle too began to breed healthily and provide more milk.' Encouraged by these results, 'villagers also began to re-create the social and cultural conditions which had existed in the past which ensured a healthy relationship between villager and environment. The infrastructure existed in the memories of the elders. And so began a resurrection of the ancient ways, a ritualisation of conservation.' [238, Goldsmith]

Economy of Permanence

If Gandhi were alive today, he would undoubtedly have a lot to say about plastics. His basic premise was sustainability, embedded in village culture. His loan voice in the Nehru technological wilderness of development has a stronger reverberation these days, as most of what he had warned about has become reality.

> 'Millions of Indians are caught in tension packed lives in crowded filthy cities. Most Indian villages have receded still further from the dream of creative self-sufficiency. Farmers have become dependent on chemical fertilisers and pesticides that are destroying the soil and poisoning the food chain. The emergence of rural rich did not improve the lives of the majority; even clean drinking water has become scarce in many villages. This threatens the survival of those who once managed a subsistence living off the land.' [27, Bakshi]

A growing number of people are beginning to realise that the way India has 'modernised' was not to her benefit, and that a Gandhian way has a lot to offer India in the 21st century. Professor Swaminathan obtained his doctorate in genetics from Cambridge University in the UK. As a government research scientist in the 1960s, he showed that India could triple its production of wheat using different varieties, chemical fertilisers and pesticides. India did so, and in a time of drought Swaminathan became a state hero. Now his views have radically altered. The world has changed, he says, since the Green Revolution that he helped launch. 'What is needed now is to help the poorest realise their potential. The future must start with the small farmer and women. We must go back to the Gandhian concept of production by the masses, though not of mass production.' On reflection, like many others, he regrets that the Green Revolution was not more ecologically or socially thought through. [239, Vidal]

Fifty years before the north focused on the need for 'sustainable' systems, Gandhi and his followers were formulating similar ideas based on existing practises in rural India. The principle inheritor of Gandhi's economic vision and his work on village industries was accountant/economist J.C. Kumarappa. Like his mentor, Kumarappa had nothing *new* to say. He simply observed the complementary manner in which nature's various creatures co-existed and drew from it lessons for human society. In his proposed 'Economy of

Permanence: A quest for social order based on non-violence', Kumarappa contrasted the 'economy of permanence' with the 'economy of transience'. The latter is most dramatically manifested in the massive use of chemical fertilisers and pesticides that gave high crop yields in the short term but eventually destroyed the soil.

A difference between many northern advocates of less resource intensive ways of production systems and Gandhians is that Gandhians emphasise the need to start by asking political and social questions at the grass-roots level. The early followers of Gandhi were trained in northern scientific disciplines but all realised that to make their ideas work they had to implement them in the local communities they were hoping to revolutionise. Unless their ideas became accepted, or as Moser puts it, 'embedded' in the culture, they would fail.

Self-sufficiency

Central to Gandhi's idea of sustainability was 'swadeshi', translated as economic freedom or self-sufficiency. Gandhi meant by this a decentralised system of governance, where people were given greater access to, and control over, the natural resource base of their own localities. According to the swadeshi philosophy 'everybody possesses both materially and morally what they need to design their own society and economy, and can therefore free themselves of oppressive structures'. Swadeshi was built 'on a community's existing resources, skills and institutions, and transforming them where they were inadequate'. Resources, institutions and structures imposed from the top down are not only non-sustainable but enslave people through their dependencies. 'Swadeshi is the basis of economic freedom and without economic freedom there can be no political freedom, or self governance or self-rule.' [240, Shiva]

Universal and local

Professor T Karunakaran, another exponent of Gandhian practices, described the economies of scale, such as that practised by Reliance with commodity plastics, as wholly unsuited to India. He predicted they 'would have inherent environmental and social costs'. [27, Bakshi] Karunakaran's answer was 'networking', a multi-tiered structure of rural industrial activity that would foster a village-centred

economy that was sustainable and eco-friendly. Karunakaran recognised that a fully self-sufficient village is no longer possible in the middle of the 20th century, but, he said, clusters of villages could work together to attain self-sufficiency through co-operation.

Each network of clusters would generate all essentials of life and even export certain items to other networks.

> 'We have to strive for a path that is between the idolised village industry and multi-national companies. All 'universal' products, starting with food, clothes and shelter, should be made in the village. But a heart pacemaker, for example, is not universal and can therefore be made in the cities. Gandhi's concept of swadeshi was that the more universal a product is, the closer should be its domain of production.'

It's a solution proposed by Professor Barry Commoner with regard to reducing the amount of plastics: 'A return to labour intensive traditional materials except in those instances – phonograph records or heart valves – where plastic marks a true innovation.' As chief techno-economic officer at IIT Chennai, Karunakaran and his team identified 350 types of consumer goods, falling into 24 major categories, which could be easily produced in villages. Most of these goods are either personal or household items, for example, utensils, soaps, matchboxes, clothes and shoes. In this scenario many commonplace products made from commodity plastics would be made, as before, by village artisans from traditional bio-based materials.

Goan architect Gerald da Cunha observed that the majority of building materials could be locally sourced from stone, clay and renewable resources. Communities could be encouraged to grow renewable wood or bamboo for construction. In Mussourie, UP, a foresighted builder 200 years ago constructed a Doedar wood house and at the same time planted a forest of Doedar in case the timber needed replacing by future generations. As we have described, it is only by effective forest management and judicious farming that forests will be preserved. The needs of forest dwellers can be met by marketing sustainably grown timber for uses that plastics threaten to replace. If forest dwellers no longer have to deplete limited grazing lands to survive they would act as guardians of India's rich and invaluable forest bio-diversity.

Most of rural India already has a sustainable agricultural system for feeding the local community. Bio-plastics could be produced in decentralised workshops, close to sources of bio-mass. Energy too could be provided locally. Emphasis on local rather than national production requires fewer infrastructures and therefore creates less pollution. Extended power grids could be replaced by energy generated by mini-hydels, wind-turbines or solar panels. 'A community that consumes locally produced goods and services exports less capital and makes less demand on resources such as energy for transportation'. [241, Hawken]

Self-reliance does not mean isolation. Communities will need to trade when they cannot meet all their needs from their own resources. A community maintains its self-reliance, according to John Galtung, by ensuring that it trades 'horizontally', that is with other communities of similar size. In a national context India would trade with nations of similar economic power, so as not to become dependent and threatened by the power of the MNCs and the more powerful and resource-hungry economies of the north. [217, Reid] As Gandhi said, ' I want the cultures of all lands to be blown about as freely as possible, but I refuse to be blown off my feet by any'.

Specialised and global

So what about the services and products that cannot be made locally? The heart valves and phonographic records cited by Professor Barry Commoner and Karunakaran? The specialised materials and products of 'unique importance' of that cannot be denied to people? Since their time of writing the vinyl (PVC) record has been replaced by the compact disc made of polycarbonate, and another revolution has taken place: the Internet and e-commerce. E-commerce is set to grow exponentially in the 21st century. Asian Internet users are projected to soar by 40% to 64 million in 2003, generating billions of dollars in e-commerce and advertising revenue. The number of Internet users in India will explode to 2 million over the next 2 years from the 1999 level of 250,000. [81, Noronha] The spider's web of Internet is encased in plastic although the growing use of radio and microwaves for data transmission can reduce the amount of material throughput. Computers, satellites and telecommunication – all require specialised

plastics, from the dish to the handset, and current bio-based materials cannot yet replace these oil-based plastics.

This revolution both enables and prevents the practice of using locally produced goods and reducing material consumption. Currently Internet companies are valued regardless of material or immaterial output, but on a 'virtual' projected profitability. Its products are both material (goods, clothes, books etc) and immaterial (music, software, services etc). Internet enables the consumer to shop at the other side of the planet, as well as down the road. Its language is predominantly that of (US) English, and so is its sales pitch, which glorifies the ease of consumption that e-commerce allows.

Internet increases global inequality says UN

'The Internet is contributing to an ever-widening gap between rich and poor which has now reached grotesque proportions, according to the 1999 UN Human Development Report. The UN report says the Internet provides enormous benefits in terms of improved information and contacts. However, it is mainly used by educated young white males with access to money. They give Internet its voice, value, and consumer preferences. The report condemns the polarisation between those who are able to take advantage of the benefits of economic globalisation and technological advances like the Internet, and those forced to suffer its effects. It says that, for inequalities to be reversed, the rules of globalisation need to be rewritten.' [81, Noronha]

At the same time, Internet has been described as the ultimate expression of democracy. Anyone (that is anyone who has access) can acquire, publish and share information. The Internet enables people to work from home, yet have access to a world-wide source of information. This has wide social implications as well as potentially reducing transport infrastructure requirements. The workplace can be virtual, not physical. Services are provided electronically without the need of material throughput. However, 10 years ago with the advent of desk top computers we all heard about the potential of the paperless office, and at the same time saw sales of paper escalate as people outputted more and more through printers. Whether the Internet revolution provides real 'satisfiers' or 'pseudo-satisfiers', remains an open question.

Gandhian flaws

A fundamental flaw in the Gandhian philosophy, say Gadgil and Guha in their book Ecology and Equity, is its emphasis on voluntary restraint – Gandhi's belief that people should remain content to fulfil their basic material needs without aspiring to greater amounts of material goods. 'While it appears materially impossible for India's 150 million families to own refrigerators and automobiles, they are all bound to aspire to do so.' [26, Gadgil and Guha] Gandhi's moral exhortations are unlikely to bear fruit in today's climate where people are caught up in the spiral of consumerism.

> 'Gandhi's vision of a decentralised, self-sufficient India is folk memory now in the capital, New Delhi. The needs of business and the cities dominate the social and political debate, and the young professionals want to reap a western harvest of cars, video and mobile phones. There is no nostalgia for the closed economy their parents knew and the once-revered Indian peasant farmer is now a shadow in the land.' [239, Vidal]

Fifty years ahead of his time, Gandhi extolled a sustainable holistic approach. At the time and, even now, his ideas are rejected. The Gandhian dream of self-sufficient, frugal village economies throughout India has seemingly foundered.

Gandhi undermined

Karunakaran said 'The last fifty years have seen many excellent micro-level experiments all over India. But they have not added up to significant macro-level changes'. The Gandhigram Trust, a key project of Karunakaran, is a classic example of 'well-meaning schemes for craftsman and rural poor who never multiply large enough to change the larger picture.' As late as 1994, the Gandhigram Rural University itself did not offer courses in organic and natural farming, because it functions on rules made by the University Grants System.

Even at the time, Gandhi's ideas were not supported by the Congress elite, enamoured of northern ideas of progress through technology. Today the Indian government still does little to support alternative visions. The modern Indian State has established such a 'close relationship with modern science and technology that it has

now become the major source of attack on all non-modern systems of knowledge'. [242, Nandy]

Comparative values

Those that followed Gandhi such as C.V Seshadri (CVS) argued in the 1970s and 1980s that environmental problems were not amenable to mere managerial and scientific/technical solutions. Like several thinkers in the north, CVS traced the roots of the environmental crisis to the primacy of the biblical notion of man's domination *over* nature. He realised it made no sense to talk of ecology unless this fundamental idea of western science and belief was challenged.

> 'God created humankind in his image; male and female he created them. God blessed them, and God said to them, 'be fruitful and multiply, and fill the earth and *subdue* it.' [243, Book of Genesis]

Whereas in India as Vandana Shiva puts it, 'the Earth community has never been seen to be dominated by humans. All species are part of 'Vasudhaiva Kutumbhakam', the Earth family'. [240, Shiva]

Modern technological processes, CVS argued, create order in a controlled setting only by generating a greater disorder outside that sphere. The 'progress' of modernity created enormous prosperity in the north only at the cost of disintegration of resources and cultures in the colonies. Modernity was and is being sold as inevitable, yet arises from specific historical and cultural roots.

The development paradigm that India has now embraced originated in the specific social, cultural and economic context of northern societies, particularly in the US. In chapter 2 we showed how the history and growth of the plastics industry was also embedded in the same historical context. The societies of India and the US are radically different both socially and culturally and one would expect very different approaches to economic polices and the uses of materials. What we can see is that India has been further colonised by the north, by a technical culture that *appropriated language* to establish the moral credibility of its new world economic order after World War 2. We need to examine history to realise that materialism and the global destruction that it has wrought evolved from a set of *values* that are not global or necessarily universal. However, aided and abetted by its control of the media, we are all being persuaded otherwise.

'Steady State' and 'Big Bang'

India could be described, using an analogy from cosmology, as 'steady state'. Despite the waves of conquerors and plunderers from Vedic times to the British Empire, India has remained steadfastly rooted in an ancient past, a million villages held together by tribe and family and a complex web of castes and creed, where roles and social functions were prescribed by birth and passed unchanged through generations. Material needs were once supplied through interlocking barter arrangements of traditionally established roles. As we have said, modernity has changed India forever yet traditional myths, ceremonies, rituals, mutual aid, hospitality and networks of familial solidarity still remain.

In contrast, using the same cosmological analogy, US civilization could be characterised as having evolved through a 'big bang'. The first settlers from Europe were white Christian zealots who emigrated to escape religious persecution. They were strangers to a 'New World' but sought to subdue its indigenous populations and novelties of nature, confident in the power of their God and the superiority of their European cultural values. Subsequent 'frontiers' men and women conquered the native American populations to near extinction at the point of a gun and appropriated their lands. Waves of pastoralists from the UK, Scandinavia, Germany, the Netherlands, and elsewhere in Europe, established farms and settlements on the pattern of the 'Old World'. Slaves were brought from Africa to work plantations of cash crops such as cotton. Immigrants from Ireland, Russia and Italy, fleeing famine, religious persecution and poverty, flooded the cities. Eager to make 'good', these new immigrants filled the sweatshops and factories of the cities at the bottom of an often-short climb to riches.

North America was vast, under-populated and blessed with a cornucopia of natural resources. Entrepreneurs exploited the wealth of iron ore and oil, building giant corporations. Labour was always in short supply to tame an ever-diminishing wilderness. Cheap oil is the oft-quoted foundation stone of the American economy, and its wealth. In the early twentieth century cheap credit fuelled the purchase of mass-produced machinery to conquer once-virgin lands. 'A drop of sweat used to grow a grain of wheat - that was true when perspiring men and lathered horse toiled in sun-beaten field. But

modern machinery has helped to lift the burden of horse and man drudgery. Today a drop of oil raises a hundred stalks of wheat', extolled a tractor advertisement from about 1910. [244, Raban] Today, wars such as the Gulf War against Iraq protect US access to cheap oil supplies as its own reserves become depleted.

Fiercely entrepreneurial, restless and democratic, the new, mostly white citizens of North America refused the social demarcations of the Old World. There would never be any division between opulent castle and cringing peasantry in this new society. The dream of the average family was a home with land and space. A life filled with every imaginable labour saving device: a car or two, TV, washing machines, refrigerators, and an almost unlimited choice of material goods. The US became *the* materialistic consumer society exploiting its own and global resources to maintain the momentum of growth. As US artist Andy Warhol once said, 'buying is much more American than thinking'.

India has not needed to follow this path. In traditional cultures such as India's people can still live and prosper within the boundaries of their local ecology and preserve their ecology as their vital vested interest. They work their ecology according to how it is, from the rich arable land of the Punjab or a southern paddy field. Their future is the future of nature around them. As Illich says, generations have had, by necessity, to live within very narrow limits, defined differently for each place and time. [3, Illich]

The northern paradigm has lost the capacity for self-limitation by divorcing itself from nature, which sets its own limits. This is how capitalism flourishes and, despite the optimism of northern ecologists such as Hawkins, Lovins and others, it is difficult to see how it could be reversed or substantially changed, except by dismantling the system. Marx was the first to point out that capitalism requires world-wide expansion: anything else is just a pause for breath. Globalisation is the true logic of capitalism and we are still in the early stages of its evolution.

To follow the path of swadeshi, self-reliance, community identity, small is beautiful, is a hindrance to globalism. The key question, then, is how do traditional values withstand the all-pervading power of globalism? How do sustainable materials withstand the globalised push of the plastics industry?

One way is to cling to the distinctive markers. 'As conditions of material life become progressively more uniform, as the 'market place' in which we all supposedly operate becomes more insistently international, so the distinctive markers of cultural difference and uniqueness are clung to all the more desperately.' [245, Collini] When we see it in the rise of Hindu fundamentalism in India it is called communalism', 'identity politics' or 'assertion of heritage', depending on the values of the commentator.

Instability is becoming the norm, as capitalism reaches its historical apotheosis. Few cannot now opt for either one or other of universal or local polarities. We have to now accept that stressful duality between the two is our common lot. In terms of the future we live both in hope and fear.[245, Collini] Only by understanding how this situation has arisen and asserting control over the direction of our lives can these fears be addressed.

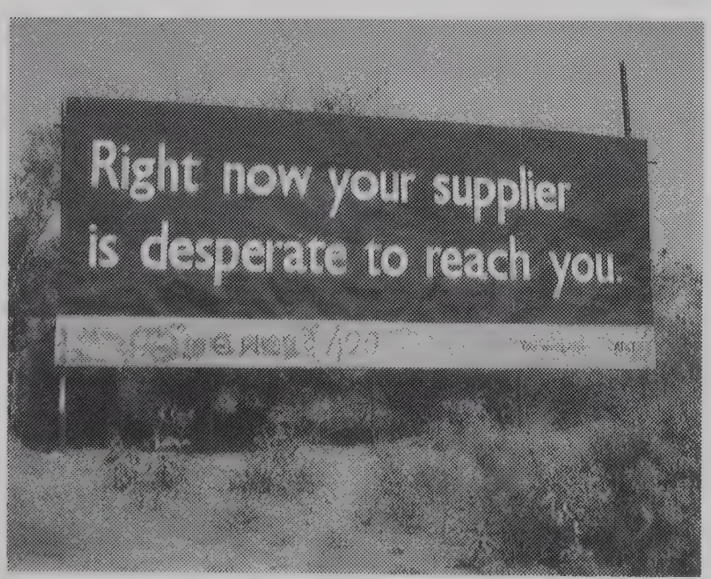
18 Dependence, needs and satisfiers

'A satisfied people are stagnant people.
After satisfying immediate desires,
merchandisers should see to it that
Americans are never satisfied.'

J.W. McCoy, Du Pont vice-president, 1945

'The needs of the Amazonian tribes are more
than satisfied by the rich rainforest; their
poverty begins with its destruction.
The story is the same for the Gonds of
Bastar in India or the Penans of Sarawak.'

Vandana Shiva, The Development Dictionary, 1997



The knowledge of the end of finite resources, of social inequality, of the toxicity and harmful environmental effects of materials such as plastic is clearly not enough to precipitate change. Most of us realise what is happening to the planet but in our day to day lives, individually and collectively, we voluntarily take part in an economic system that feeds our need for ever-increasing material consumption.

A change of this perception lies beyond the scientific facts, the rhetoric, the chattering of monkeys, to our differing cultures and similar needs. We must understand the assumptions and values behind why and how we choose to satisfy our needs both materially and immaterially. As Tim Jackson observed, 'the obstacles which now stand in the way of a reorientation of the industrial economy relate more

to the psychology and sociology of human behaviour than to technical considerations or physical constraints'. [22, Jackson]

In the 20th century, economic growth, enabled by science and technology, has been perceived as the primary 'liberator', and through economic growth we have 'progress'. This was the message to 'under-developed' countries from leaders such as the US Presidents Truman and Kennedy, and institutions such as the World Bank and IMF. It is still the way that progress is generally measured today. It is the role model India is adopting with industries such as the petrochemical industry and its products.

A large constituent of economic growth is the continual search for material well being. The previous limits of nature are constraints to this progress, as the infinite wants of human beings are opposed to the finite resources of nature. E. E. Schumacher, in his seminal work, Small is Beautiful, observed back in 1973 that 'modern man does not experience himself as a part of nature but as an outside force destined to dominate and conquer it'. [18, Schumacher] The technology of plastics was born in this age. Its material properties appear to enable our freedom from nature, replacing the irregularities and flaws of natural materials with its regularised mass production.

As we approach the end of this age of hydrocarbons our plastic encased world is in one sense becoming the opposite of free. The industrial economic revolution of the last 200 years is sounding the death knell for the earth, through our plundering of resources and poisoned waste products. It has left most of us in the 'developed' world without any *independent* access to food, water, clothing or shelter and at the same time has increased our appetites and our sense of need. Especially in the north, we can see how much we have accepted an absolute dependence on man made, machine-cast industrial goods. We have become 'hostage to an ever-accelerating treadmill of production and consumption'. [246, Pruiksma].

Commodity plastics have intensified this dependence and increased our 'needs'. The two – dependence and needs – feed off each other, in an ever-tightening spiral. As Illich says, they have led the 5 billion people currently alive to 'accept unquestioningly their human condition as one of dependence on goods and service, a dependence which they call need. In just one generation, needy man – homo miserabilis – has become the norm'. [3, Illich]

Removal and dependence

The longer and more complex the strings of mers (that make up plastic polymers), the further they remove us from the physical world. The more complex the technological chains, the more energy and resource inputs they require, creating more pollution and unresolved waste. One of plastic's most eloquent critics, the US author Norman Mailer, found that the lifeless conformity in the 1970s attained material embodiment in plastic. We had 'divorced ourselves from the material of the earth, the rock, the wood, the iron ore...We looked to new materials which were cooked in vats, long complex derivatives of urine which we called plastics'. These new materials lacked 'the odour of the living...their touch was alien to nature'. [247, Mailer]

Removed from nature we have become dependent on technology. How many tourists in India have you seen *not* clutching a plastic water bottle? Its modern technology (plastic) holds an ancient necessity (water) that has now become a modern commodity. Ultimately the traditional *necessity* of keeping our water clean has been transformed into a new *need*, to buy bottled water. We are now dependent on industrially purified water in machine-made plastic. The dependence has created 'progress' in the form of two new markets – plastic and water.

For a tourist, buying a water bottle is a liberation, freeing them from potential water-borne illnesses. The plastic container is security, sealed, transparent, light and easily carried – a familiar non-partisan material. The tourist has the economic freedom to purchase the commodity, a freedom the local citizen may not have. The economic freedom of the tourist is not only inequitable; it undermines the sustainability of the natural system he/she is travelling through.

The more removed we are from the source, the less we know, the less we want to know, and the less we understand the full cost to our environment and ourselves. Do tourists who buy the water bottle know what the plastic is made of? The hazardous chemicals used in its manufacture? Do they consider that their daily action of buying bottled water undermines the claim to clean water of the permanent community? And when the tourist discards the bottle who deals with the waste? How much does the knowledge of the end of finite resources count against the convenience of accepting a plastic bottle

of cold water from a CFC fridge? Otto Ullrich, engineer and sociologist, describes this as 'the separation of an act committed now from the suffering that will ensue, or the non-intersection between advantages that are privately consumable and disadvantages that have to be borne collectively'. He describes this temporal, spatial and personal separation of utility and cost as an exceedingly seductive characteristic of modern scientific technology. [28, Ullrich]

Plastic packaging facilitates a process of globalisation, removing food and products from their sources to the global market. Increased use of plastics in packaging, especially of processed foods, enables the conversion of agriculture to cash crops. 'With the spatial distance that the product covers on its way from its place of production it appears quite different in the distant market place. There, the product, now a commodity, realises its economic value, and simultaneously gains new qualities as an object of consumption.' [248, Robert]

The more complex the plastic material and the more sophisticated the technology, the harder it is to truly understand how it affects our environment and us. We therefore become dependent on 'experts' to advise us. We must grapple with arguments in 'Risk Assessments' and 'Life Cycle Analyses'. Safety standards have to be constantly changed, as our scientific understanding grows to show that ever smaller concentrations of chemicals are harmful. Only recently has science discovered that complex chemical additives used in soft PVC toys can threaten the health of babies sucking on plastic teethers. Must we wait for science to become ever more sophisticated to tell us we are ruined and made barren by the things we've created?

We become increasingly dependent on the law and its implementation to ensure that worker safety standards are maintained and wrongdoers punished. The law has to acquaint itself with this complex chemistry. An elaborate chain of check and balance and implementation has to be constructed to protect the community from chemical hazards. We have become dependent on know-how and expensive technology to 'clean up' our created chemistry.

The further removed we become from the source of our materials, the further away the responsibility. Plastic producers are eager to find a solution to plastic waste, disturbed by their public image of plastic littering the landscape, but they are determined not

to accept any responsibility. It is left to the ragpickers and the cows – both in everyday contact with plastic waste – to sort out our mess.

Tradition – the final barrier

As a material that has successfully shed all vestiges of its particular origin, place and context, plastic belongs nowhere and can penetrate everywhere. It appears cleansed of any attachment to a particular culture and is therefore powerful in remodelling any social reality, unsettling all kinds of different cultures.

Plastic rejects the things of nature it is replacing. 'By its own internal logic, each new petrochemical process generates a powerful tendency to proliferate further products and displace existing ones,' said Professor Barry Commoner. [29, Meikle] This works on many levels, financial, environmental, social and cultural. The once large jute industry will undoubtedly be over-taken by the mechanised and urbanised polypropylene industry. Jute replenishes the land it comes from; its production involves families and social networks. Around 30 million people are estimated to work in jute, directly and indirectly, and less than an estimated 10% will remain. Its end will destroy a tradition, the predominantly rural families that were once employed and the very fabric of an Indian society it has helped to mesh and nurture.

Gerald Berthoud, who has researched the history and anthropology of the market, describes traditions as symbolic and moral *obstacles* to our globalised progress. 'To produce a global growth in a traditional society, presupposes overcoming symbolic and moral obstacles, that is ridding these societies of various inhibiting areas and practices such as myths, ceremonies, rituals, mutual aid, networks of solidarity, and the like.' [2, Berthoud] It is a trait observed in 1980 by John Galtung, then professor of peace studies at Oslo University, Norway.

The Cork story

The impact of plastic on the social fabric is not only happening in India and the 'developing' world. It is also affecting rural economies in the north. One small patented US product, the plastic cork for wine bottles, is threatening rural communities in Spain and Portugal.

Traditionally, wine bottles have been stoppered by cork from the renewable bark of the cork tree, providing expert work for artisans in this area of southern Europe, where cork trees take 40 years to grow before they can offer bottle-quality cork. In just 5 years, the plastic cork, made of synthetic rubber, waxes and polyolefins, has swept through the global wine trade. One US Company, Supreme Corq, supplies 300 major wineries with more than 200 million synthetic corks a year, and is now seeking to open factories in all major wine-producing countries.

'I'm really worried', says Roderick Reynolds, who owns 1,000 acres of cork trees. 'If plastic really catches on, the value of the cork trees will drop. At the point where it is more economic to grow other trees such as eucalyptus and pines – which are disastrous for the environment – the farmers won't plant new cork trees and will dig up the old ones. It could take just five years for the great cork forests to go, and then one of the very few sustainable industries in the world would disappear.'

Slowly, and then with a rush, would go many thousand of cutters, growers and producers. Out, too, would go the birds, the pigs, the wild boars, the rabbits, the game, the mushrooms, the charcoal industry and the firewood industry that all depend on the cork forests and sustain the culture of much of southern Portugal and Spain. [249, Gluck]

Technological innovation which accompanies development is not just a matter of technical advance – the importation of superior but culturally neutral knowledge, skills and equipment – but also imposes alien cognitive and behavioural patterns. It leads not just to changes in material standards of living, but to a cultural and even psychological dependency in the people who adopt the 'superior' technology. At both individual and community levels people respond to economic pressure by buying the products, adopting the lifestyle, assimilating the values and eventually sharing the preferences and assumptions of the dominant power. Galtung calls this 'the silent

subversion of local culture through the culture and structures that always accompany the import of foreign techniques and material things in general'. [217, Reid]

How much more important is clearing land for a huge petrochemical complex than the lives of a local community who have buried their umbilical cords there, worked the land and lived off it, contentedly and sustainably for generations? One can understand the intensity of social conflict in India and the desperation of people that have everything to lose by 'development' projects. Author Arundhati Roy estimates that 50 million people have been displaced by development projects in India. 'This is almost three times the population of Australia. A huge percentage of the displaced are adivasis, dalits and the scheduled castes.' According to Roy, 'the millions of displaced persons in India are refugees of an unacknowledged war. And we are condoning it by looking away. Why? Because it is being done for the sake of the common good. It is being done in the name of progress, in the name of national interest'. [13, Roy]

On the one hand we instigate a complex web of high maintenance, expensive plastic piping and mega dams for irrigation. On the other hand are the seasonal and age-old watershed methods of check dams that use local bamboo for the piping, a naturally abundant and replenishable material, with local technical know-how. Dependable and independent. Cocooned in cities, do we know any more how to build with the natural materials of wood and bamboo, how to design a house without the need for an air-conditioner? 'The Japanese speak of the 'new three sacred treasures': colour television, air conditioning, and the automobile.' [246, Pruiksma]

The typical tradition of repair and re-use in India is disappearing, as cheaper goods such as PVC chappals come on the market – so cheap it is not 'worth the while' repairing them. The north lost its traditions and respect for what it made long ago, and now accumulates landfills of generic rubbish it does not know how to deal with. How long will the Indian cow survive on the plastic we are now feeding it?

The current mode of economic development is not compatible with the maintenance of traditional customs and mores. A break with the latter is a prerequisite to economic 'progress'. Karl Marx

identified how capitalism tore apart all old social ties and traditional relationships to nature, and substituted universal exchange mechanisms. And what are these idiosyncratic traditions replaced by? A globalised consumption, a desire for wanting more than is obtainable:

> 'Therefore, what is required amounts in reality to social disorganisation. Unhappiness and discontentment in the sense of wanting more than is obtainable at any moment is to be generated. The suffering and dislocation that may be caused in the process may be objectionable, but it appears to be the price that has to be paid for economic development; the condition of economic progress.' [250, Sadie]

What freedom is this? The 'freedom' to devote ourselves to consumption; to set aside local subsistence knowledge and become dependent on external 'market forces'; to shield ourselves as far as possible from the responsibility of knowledge and the collective responsibility to our planet and ourselves. Individual freedom, this cardinal value of our northern cultural system, thus involves the boundless use of all manner of resources, and a total break from previous social and communal obligations.

Profit at any cost

The capitalist system has facilitated the recent rise of market fundamentalism. The ultimate expression of market fundamentalism is global free trade, which forces the abolition of national trade barriers in order to create greater global wealth. In practice it means the survival of the fittest – mostly the northern multi-national corporations (MNCs) and their economies of scale, which dominate and thereby undermine the sustainable non-profit centred systems of the south.

Market values have substituted money for intrinsic values. Market fundamentalists argue that whatever social values are, they find their expression in market behaviour. But in the market place morality, like tradition, can become an encumbrance. With application to the financial markets George Soros, the marketer turned philanthropist argues, 'Financial markets are not immoral; they are amoral. The fact remains that anonymous market participants are largely exempt from

moral choices as long as they play by their rules'. These are not the less easily defined rules of social or intrinsic values, but formal market rules, where the profit motive has been promoted to a moral principle.

> 'The common interest does not find expression in market behaviour: Corporations do not aim at creating employment; they employ people (as few and as cheaply as possible) to make profits. Health care companies are not in the business to save lives; they provide health care to make profit. Oil companies do not seek to protect the environment except to meet regulations or to protect their public image.' [251, Soros]

Only the profiteers come out on top, in a hostile natural selection. This subversive process potentially transforms all human activity into products and then commodities. Our earth resources are not valued, except as material goods packaged, bought and sold as tradable commodities. The earth does not benefit, as its resources are stretched to extinction. And the majority does not benefit, as it excludes the surviving members of indigenous peoples and large numbers of people north and south who lack purchasing power and access to means of sustenance. Personal accumulation of material wealth has become so embedded in our present culture that it is almost inconceivable to us that any other motive could govern our daily life. 'With wealth as a supreme value, life counts less. The social imperative is to get money at any available means.' [2, Berthoud]

The creation and manipulation of needs

Economic rationale demands continued growth. Continuous growth has to create needs. It is a new culture – a culture of expectation and need. 'The needs that the rain dance of development kindled, not only justified the despoliation and poisoning of the earth; they acted on a deeper level. They transmogrified human nature.' [3, Illich] Illich describes the transformation, which like the institutionalised profit motive is relatively modern: where there was once *necessity*, there is now *need*.

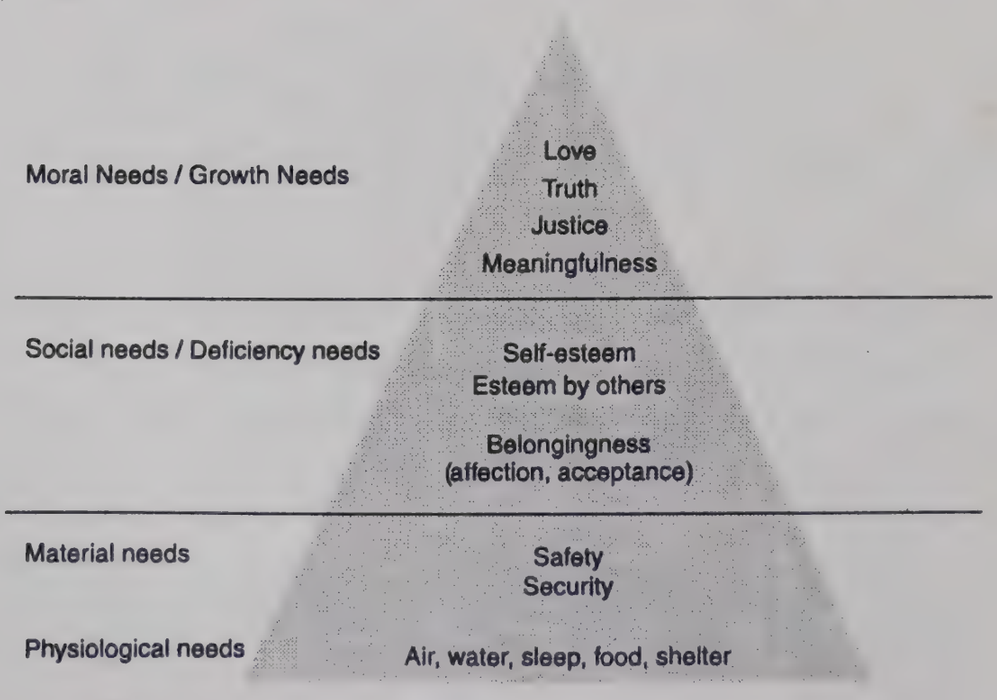
> 'Well into the industrial age, for most people living in subsistence cultures, life was still predicated on the

> recognition of limits that just could not be transgressed. Life was bounded within the realm of immutable necessities. The soil yielded only known crops; the trip to the market took three days; the son could infer from the father what his future would be. For need meant of necessity 'as needs be'. Development came along and offered a promise to break the rule of necessity using the powers of science, technology and politics. Enter hope, expectation, desire and need. Needs have only very recently become a universal experience.' [3, Illich]

Needs, say Illich, 'are a social habit acquired in the 20th century, and a habit that needs to be kicked in the next'. Not only are there needs, but there is a blurring of understanding between the words 'needs' and 'wants', abetted by the ferocious attempts of marketing agencies, advertisers, profiteers and racketeers to persuade us that what we want is what we need. 'Conventionally speaking, economics translates all needs as 'wants' or consumer preferences, and then makes the grand assumption that these preferences are expressed by the monetary values of goods and services traded in the market.' [22, Jackson]

A key question in the development debate is *who* defines our needs and 'satisfiers'? And *how* are these needs defined and satisfied? For example, how do commodity plastic products serve our needs and who is promoting plastic as a material to meet those needs?

Table 28 Maslow's Hierarchy of Human needs



Maslow's hierarchy and Max-Neef's matrix of human needs

Abraham Maslow's hierarchy of human needs (1970) has somewhat belatedly become influential in the recent needs debate. His model stretches from basic physiological needs – air, water, food, shelter, sleep, through 'deficiency needs' which satisfy 'self-esteem' criteria, to what Maslow calls moral needs – love, truth, justice, meaningfulness.

Maslow held that the higher needs remained latent until the lower needs had been satisfied. In other words, a person whose day was taken up looking for food and shelter would not look for 'social needs' or spend time philosophising on the meaning of life. This strictly hierarchical interpretation has its limitations, and in many instances moral needs are sought at the same time as material needs. But the model holds for some current examples. Indian critics of environmentalists often say, let us provide the basic human needs for the millions of poor in India before we address the luxuries of environmental safety, and question the justice or meaningfulness of it all. After all (they say), most Indian environmentalists are from the urban middle class elite who, having satisfied their basic physiological material needs, have the luxury to debate the justice of life or survival of our planet.

Looking at Maslow's model, the first layer, subsistence and protection, are inherently material needs. While there are more and less materially intensive ways of producing food, supplying water, providing clothes and building homes, they all have certain minimum requirements for material goods.

Table 29
Human-scale development: matrix of fundamental human needs. Designed by Manfred Max-Neef

	Being	Doing	Having	Interacting
Material Needs	Subsistence			
	Protection			
Non-material	Affection			
	Understanding			
	Participation			
	Identity			
	Idleness			
	Creativity			
	Freedom			
	Transcendence			

Source: [22, Jackson]

The important point, as Jackson described in his book 'Material Concerns', is that the remaining needs are *not* inherently material. Some attempts to satisfy these needs will be highly intensive in terms of material consumption, others will be less intensive. The types and amounts of materials associated with satisfying non-material needs depend on the cultural choice of appropriate 'satisfiers'. In simplistic terms, a person's need for self-esteem may be satisfied in North America by buying a Cadillac car or shopping. The same need in an Indian may be satisfied by a pilgrimage to Gangotri and the 'myths, ceremonies, rituals, mutual aid, networks of solidarity and the like' that Berthoud spoke of, inherently non-material satisfiers.

The division of material and non-material needs is even clearer in Max-Neef's human-scale development matrix of fundamental human needs. Max-Neef, who directed the work of the Chilean Alternative Development Centre, criticised conventional economic development in South America, where neo-liberal monetarism of the 1980s had an unresolved social cost. In his matrix, the 10 functional needs must be seen as interacting in a systematic way rather than being related hierarchically, with the exception of the need for subsistence, which he accepts has priority over the others. Both Max-Neef and Maslow argued that if development is to serve people it must aim not simply to raise material standards but to improve the quality of their lives.

Who defines needs?

Our material needs are often defined, not by the 'needy', but externally by others who have their own set of values (financial or otherwise). Key reports on global inequality and the growing environmental crisis such as the Brandt 1980/83, and Brundtland 1987, and international organisations such as the UN Development Programme (UNDP) adopt a 'basic needs' approach that attempts to define what they perceive as the needs of the south. Max-Neef sees this as an extension of conventional development thinking in their assumption that the production of material goods will fulfil their needs.

In this vein the Government of India seeks to address the five basics needs of its people – *roti, kapda, makan, swastha, shikhsa* (food, clothing, shelter, health and education). In the mid-1980s it sanctioned the expansion of the petrochemical industry as one of the means of satisfying these needs:

> 'The petrochemical products assist in providing wherewithal for meeting basic human needs – food, clothing and shelter. These also play an important role in medicare, education, entertainment and a variety of household requirements. Petrochemicals find application in a whole host of value-added chains which help improving quality of life.' [43, GOI Bhattacharya]

The Bhattacharya report promotes petrochemical products (plastics) not only to meet basic physiological needs, but also the second and third layers of Maslow's hierarchy 'entertainment and variety of household requirements... to improve your quality of life.' The Indian State, it could be said, has responded to people's needs by making them hostages to large-scale industrial processes and the cash economy. Take the needs of the poor. Development has encouraged people to think of wealth and poverty in material or monetary terms only. The creation of GNP equated progress with the dollar. Those earning less than US$100 per annum were defined as 'poor'. The need of the poor was thus defined as raising their income. Defining poverty in monetary terms defines economic growth as the only solution, and shuns all other resolutions.

Poverty alleviation programmes claim to be based on an assessment of 'needs'. Yet, what planners, politicians and economists tend to consider as their needs 'has little or nothing to do with what different categories of the poor perceive as their needs'. [45, Rahnema] For the many that earn barely enough to fill their bellies, there is little left over to acquire the new goods on the market. Meanwhile, the economic activities (of which the petrochemical industry is one) deployed on behalf of the poor (through the economic trickle-down effect and the products themselves) 'impute to them different needs of a more insatiable nature.... thereby exposing the poor to situations of even more complete helplessness'. [45, Rahnema]

The Government of India's shift towards liberalisation and globalisation promoted the power of the market to prescribe needs and satisfiers. The needs of industry to repay invested capital and to reward its shareholders by means of profit, means that the industry has to create ever more 'needs' for its products and services in the market. Thus, new and often artificial needs are generated by over-

production leading to *unnecessary* over-consumption that requires an ever-greater exploitation of natural resources.

> 'This is what Reliance's and Dhirubhai's biographers down the years will study clinically and confirm as his mark of genius. The daring ability to commission capacities far in excess of what the market could take at that moment of time.... It produced as much as possible – in most instances above its capacity.' [75, Mehta]

The desire for material satisfiers, driven by market creation and over-production, is aided and abetted by the global power of the US-centred media and entertainment industry. Movies and music are not just entertainment, they sell a life-style. Fast food packaged in plastics is proliferating in Indian metropolitan centres, replacing the independent Indian street vendor who wraps food in yesterday's newspaper or on leaf mould plates.

The ways in which we satisfy our similar needs, collectively and individually, that once varied from culture to culture and time to time, are now succumbing to the same 'globalised satisfiers.' 'The standardisation of desire and dreams occurs deep down in the subconscious of societies..... The vast furrows of monocultures left behind are, as in all monocultures, both barren and dangerous.' [23, Sachs] These monocultures include the mass-produced plastics turned out from extruding machines. The result is 'a world in which all could live even if none could breath... Everywhere we are assaulted by the faceless plastic surfaces of everything, which has been built in America since the war... proliferating like the metastases of cancer cells... Everything tends to look a little more alike and a little less like anything very definite'. [247, Mailer]

The needs and wants of India

India is 'catching up on the 'technology race'. Its middle class is growing, its needs are increasing, and its expectations are being voiced. Indian plastic promoters salute this as the Plastics Age. 'Our daily lives would be much poorer without these benign and environmentally friendly materials, which have a unique combination of properties.' [11, Sharma]

The consumerism of the north is immensely seductive to the citizens of India, as elsewhere. Why should Indians live in 'mud huts'

when plastic and concrete houses exist with air-coolers and refrigerators and cold sodas with cool images? Schooled in northern ways of thinking to believe the 'modernisation' of India is unavoidable, many in India 'do not understand why they should leave the advantages of plundering natural resources to the industrial countries. They want to participate in instant prosperity, and therefore demand ... 'efficient' technologies of petroleum exploitation'. [28, Ullrich]

More planets needed

There are two fundamental problems with this objective: first, it's not possible and second, who needs it anyway?

The consumer society, encased, coated, packaged and transported in plastics, is based on having what others do not have. A person's status depends on who has more and who has less. It is a fraud to hold up the image of the worlds rich as a condition available to all. It is not available to all.

> 'The push-button comforts people in the north have grown accustomed to and the unquestioned consumer expectations like running hot water at one's finger tips, continually heated or cooled rooms, motorised conveyance, food stuffs from all over the world wrapped in plastic and frozen and always available, mountains of goods people feel they can never do without and which the accelerated pace of fashion turns ever more quickly into mountains of garbage – all this American way of life, as it is often called, is composed of countless of little plunderings of nature. It is precisely this that makes up the envied prosperity of the industrial powers, and precisely this prosperity that is not generalisable globally. It can be had by only a few generations in a few countries before the earth will have been plundered to death and rendered no longer habitable.' [28, Ullrich]

In this kind of race the materially and technologically rich countries will always move faster than the rest, for 'they are the world champions in competitive obsolescence'. [23, Sachs] A clique of 20% of the world's population, specifically in rich countries, monopolises 80% of the world's resources and the material needs of

the 20% erode the livelihood of the 80%. In poorer countries, economic development, population growth, and increasing use of 'efficient' technologies are contributing to an accelerating loss of land for sustainable living together with the earth's bio-diversity. [252, RMNO]

Even if it were possible and desirable for all the world to live like Americans, ecologists have calculated that we would need between 3 and 5 planets worth of resources to do so. Per capita plastic consumption in India in 1997 was 2.1kg and is expected to rise to about 17.2kg by 2047 – this increase enables an entire consumer culture, of cars, consumer durables, etc. Gandhi foresaw this fundamental flaw in our development: 'It took Britain half the resources of the planet to achieve its prosperity; how many planets will a country like India require?' [217, Reid]

False satisfiers

The northern industrial economy has tried to satisfy non-material needs almost exclusively in material ways. Material possessions/ commodities – cars, houses, labour-saving devices, etc – reflect status, provide identity/personality and prove participation, create a sense of belonging. In some cases, material goods attain a limited measure of success in meeting these non-material concerns.

But, just as these material satisfiers appear to meet a need, they create a desire for more. More often they act as inhibitors, 'pseudo-satisfiers' and ultimately violators of our freedom. Opulence, the desired aim of many, 'does not mean the effective enjoyment of wealth, but rather the never-ending quest for 'something more' and 'something new''. [2, Berthoud] Remember the Du Pont Chairman's warning, that a satisfied people are 'stagnant people', and that, after satisfying immediate desires, merchandisers would have 'to see to it that Americans are never satisfied'. This accelerating consumerism seeks to gratify wants rather than satisfy needs. Fred Hirsch, a US Professor of Economics, pointed out that as economic growth provides more 'positional' goods (by which people define their socio-economic status relative to others), people have to consume at faster and faster rates to maintain their position relative to others. Ultimately the process is futile – there is no advantage in standing on tiptoe if everyone in the crowd is doing the same. 'Economic growth encourages a kind of cognitive dissonance and people feel

compelled to act in ways in which they do not wholly believe.' [217, Reid]

The relationship between material goods supplied by the system of 'growth economics' and non-material needs is no longer clear. In fact, it never was clear.

> 'What characterises the development of the industrial economy, and perpetuates the myth of the success of the consumer society, is the assumption that all human needs can be satisfied through material goods, and all problems that this may cause can be solved with man's technology. Accepting the existence of fundamentally non-material needs shatters that myth.' [22, Jackson]

Could it be, as Daly asked in 1992, 'that one of our wants is to be free of the tyranny of infinite wants?' [217, Reid]

Accepting non-material needs

Basic needs are similar in traditional and industrially advanced economies, but differ in two fundamental ways. First, the same needs are satisfied in much more materially intensive ways in industrial economies; they are resource intensive, and exclude and undermine the large numbers of people lacking purchasing power and access to a means of sustenance. Secondly they generate pressure to create new and wholly artificial needs, and hence the impulse for over-consumption, which in turn requires an even greater exploitation of natural resources and a malcontent, unsatisfied people. Vandana Shiva:

> 'Traditional economies are not 'advanced' in terms of wasteful consumption, but as far as the satisfaction of basic and vital needs is concerned, they are often what Marshal Sahlins has called 'the original affluent society'. The needs of the Amazonian tribes are more than satisfied by the rich rainforest; their poverty begins with its destruction. The story is the same for the Gonds of Bastar in India or the Penans of Sarawak.' [7, Shiva]

The current development paradigm is the agent of exploitative economic power, and creates a psychological as well as a practical dependence. As Galtung described in 1980, the citizen of the periphery (the south) becomes 'a pupil learning how to produce and

consume. The role of the passive pupil of alien ways is very difficult to unlearn. Dependence once established is very difficult to undo. Ultimately dependency is very unpleasant to everyone involved. Yet it is the consequence of conventional economic theory and practice.'

Human scale development, as Max-Neef and Gandhi said, means moving from dependence on a complex of closely allied and remote political and economic interests to self-reliance. Self-reliance is not 'independent', but is dependent on a social network, where personal and social developments can support one another. It is dependent on the ability of natural resources to replenish themselves. In contrast to power and money, solidarity grows when shared; knowledge is enlarged as it is communicated. A community that devises its own ways of meeting its needs does less damage to its autonomy and self-respect than one that adopts an externally-made, foreign product or technique, even if its own solution is technologically less advanced.

Addressing the fulfilment of self-interest, Soros said we must learn to distinguish between individual decision-making, as expressed in market behaviour and collective decision-making, as expressed in social behaviour in general and politics in particular. In both cases, we are guided by self-interest, but in collective decision making we must put the common interest (for example, the preservation of resources and our environment) ahead of our individual self-interest. We are not separate, independent autonomous entities, but part of the physical world, and all the constraints and mysteries therein. John Stuart Mill, the very person who was responsible for the notion of self-interested rational economic man, was profoundly troubled by the implications of his model. 'Those only are happy who have their minds fixed on some objective other than their own happiness: on the happiness of others, on the improvement of mankind, even on some act or pursuit, followed not as a means but as itself an ideal end.' [22, Jackson]

Within our own society, and within our own belief systems, it is up to us to define our needs, and be aware of the seduction of false satisfiers. In our day-to-day lives we need to ask ourselves, what do I need? How, materially or immaterially, can I satisfy this need? By choosing a plastic material over a renewable material what are the implications for my earth and the people around me, that is, my community?

Schumacher proposed in 1973: 'Development does not start with goods; it starts with people and their education, organisation and discipline. Without these three, all resources remain latent, untapped potential.' [18, Schumacher] The Dag Hammarskjold Institute stressed that meeting human needs in full means more than providing the wherewithal for basic subsistence. It requires a form of development that respects people and the distinctiveness of their traditions and culture – notions that are incompatible with a form of development that is based exclusively on economic growth.

The south has one supreme advantage – the majority of communities still live within the bounds of nature, respecting the natural systems of their environment, using traditional low-intensive methods of subsistence passed by on from generation to generation. 'We in India have this very great advantage of possessing a value system that is completely different (from that of the northern ethos) and we must make use of it in evolving our own knowledge system.' [27, Bakshi]

19 Life with less plastic

'While the 20th century can be called the age of the hydrocarbons, the 21st century should witness a rebirth of a 'carbohydrate' economy. ... Bio-diversity provides the biological capital for survival.'

Anton Moser, Institute of Biotechnology, Austria, 1995

Confronted by economic and social instability on one side, and escalating environmental degradation on the other, the northern industrial paradigm of development is itself in crisis. The roots of that development are inextricably entwined around the current economic system, and unless we are prepared to revisit and reassess those principles we are unlikely to solve our environmental and social problems. This book is about plastics and not economic theories. However, it is fundamental that in order to find a path forward out of the problems that industries such as petrochemicals create we need to question the assumptions of not only the Government of India, but of the global economic and industrial structure that plastics is part of.

An unavoidable conclusion arising from our examination of the assumptions made by the Government of India planners is that the petrochemical industry and many of its commodity plastic products are simply unsustainable.

➡ The plastics industry in the form of various products contributes to Indian economic growth by way of being a high growth industry. It is anticipated that the export of plastic products will substantially contribute to India's foreign exchange earnings.

Oil, the base material of plastics, is a finite resource and therefore its products are unsustainable in the long-term. India is deficient in oil and currently about one-third of its import costs are for petroleum, oil and lubricants. Much of India's petrochemical technology is imported, especially state-of-the art technology and 'know-how'. This technical dependency adds to the outflow of capital and makes India less self-sufficient.

A significant export industry has failed to materialise. The economics of the global industry are stacked against India becoming a major exporter of plastic products. When recent governments lowered customs duties to reduce the costs of Indian petrochemical producers, even lower-cost producers in South East Asia reacted by dumping petrochemical products on the Indian market. The cyclical nature of the industry world-wide makes it an uncertain one. India suffers too many infrastructure weaknesses, (for example, high costs of energy and foreign borrowing) to compete in the global market with the low energy costs of the US and West Asia. Thus a substantial proportion of commodity plastic products is still being imported.

➡ Expansion of the plastics industry will increase employment and skilled manpower.

The urban employment that the petrochemical industry potentially offers is exceeded by unemployment in artisanal and bio-based industries, especially the large-scale jute sector. Plastics are rapidly replacing products from these industries. The majority of jobs in petrochemicals are unskilled in hazardous plastic processing and 'recycling' operations.

➡ Plastic products are essential necessities and assist in providing the wherewithal for meeting basic human needs – food, clothing and shelter – as well as improving quality of life.

Mass produced plastic products, through volume and therefore price, are effectively destroying hitherto sustainable industries. Many plastics are used for products that are not essentials, encouraging a spiral of material consumption.

➡ With the depletion of scarce natural resources plastics are the inevitable source of many material needs.

The Government of India is denying a market for renewable materials and hence the opportunity for their regeneration by promoting petrochemical products as an alternative. At present, resources of renewable materials, such as wood and bamboo, are depleted in India. The key to their regeneration is encouraging forest dwellers to control and benefit from their bio-resources and thereby preserve bio-diversity and arrest the decline of rural economies in those regions.

➡ Plastics are environmentally friendly. A key part being their lower energy content.

All plastics, except some bio-plastics, are hazardous at some point in their life cycle from production to disposal. Hazardous industry is non-sustainable because of its short and long-term health effects on humans and the environment. The various government reports do not differentiate between the hazards arising from the various types of plastic. Government planners have not highlighted the chemical hazards faced by workers in the primary production of polymers and the processing and re-processing sectors. They have also failed to mention the potential hazards faced by consumers of plastics. At least one government report has enlisted industry to prepare an ecological defence of plastics based on limited and highly selective criteria to do with energy used in its production. Protecting local communities and the environment from accidents and discharges of hazardous chemical wastes is left to a regulatory process that is clearly inadequate.

➡ India can effectively deal with plastic wastes through the informal recycling sector.

By condoning an informal and unregulated plastic recycling industry the Government of India is allowing continued exposure to toxic hazards. Those involved in the recycling process, ragpickers and urban slum dwellers, are at risk, and so are consumers as the

reprocessed plastic products often contain excessive amounts of toxic additives. Plastics are are not effectively recycled but 'down-cycled' to inferior products that hardly impinges on the virgin plastic market. The plastic industry does not, nor does is it intend to, reduce the amount of virgin plastic produced, which is a main objective of materials recycling. Plastic producers refuse to take responsibility for the environmental impact of their creations after they have left the factory.

Reliance prospers

The one obvious benefactor of the government planning process has been Reliance Industries. This upstart in the petrochemical industry in India now dominates the internal market, to the detriment of older players such as Chemplast and NOCIL and, to a lesser extent, IPCL. By creating huge over-capacity Reliance has been able to cut costs and margins on prices, thereby widening the market for its products.

For many of its commodity plastic products, Reliance, like its US counterparts, has created rather than met needs. It targets the domestic market – the 300 million growing middle-class – and provides cheap 'necessities' for the poor. To soak up Reliance's planned capacity India will have to consume more plastics, increasing the environmental and social problems caused by plastic production in the first place. Indeed Reliance is starting to have an effect on the import of some commodity plastics. One result of the petrochemical planning process is that India, through the success of Reliance, could become more or less self-sufficient (while still having to import raw material like oil) in an unsustainable product.

Questioning assumptions

Let us assume that government planners have honest intentions, that they are working for a 'better India', that it is not their intention to make the poor poorer, nor to squash rural traditions in favour of a dominant urban industrial system. What we then see, is that they have 'bought into' the mind-set of the northern industrial paradigm, perceiving development in India largely in terms of growth economics and technological solutions. 'For a poor country like India,

the imperative of rapid economic growth remains paramount.' [19, Tata Energy Research Institute][12]

The chairman and members of these various planning committees are mostly middle-class, middle-aged men, educated to believe in northern technology and ideologies such as the 'trickle-down effect' and 'economies of scale'. These methodologies are seen as the only ways of digging the masses of India out of so-called poverty, and of trading in the world economy. These were the prevailing beliefs of the global technocracy in the 1940s to 1960s when the mindset of the planners was formed.

If there is one key message in this book it is that continuing with the present model of economic growth that measures growth by material throughput, is potentially catastrophic. This fact, once in the realm of doomsday outsiders, is now acknowledged by the mainstream.

Although marginalised during the latter part of his life and in the last 5 decades, Gandhi's vision is most relevant now, and many of his messages are central to current ecological thought. 'A sustainable view of progress would have clearly defined objectives – not of growth and aggrandisement through expansion, domination and competition, but of sufficiency, equity and security founded on co-operation rather than competitiveness; participation rather than token consultation, oppression or exclusion; empowerment rather than deprivation and dispossession; and self reliance rather than dependence.' [217, Reid]'Sustainable Development', for all of its problems of definition and appropriation by the corporate world, in spirit recognises the need to alleviate both the global resource and environmental crisis in a systematic way that integrates social, ecological and economic factors. The goal is non-resource depleting, non-polluting, socio-economic systems which, in Bruntland's definition, 'can meet the needs of the present without compromising the ability of future generations to meet their own ends'. [24, WCED]

[12] TERI, consultants to the Government of India, in its GREEN India 2047 (Growth with Resource Enhancement of Environment and Nature) project. TERI is proposing a 'whole range of possible scenarios with elaboration of policy as well as institutional changes that are essential to move the Indian economy in a direction of sustainable, but healthy, economic growth'.

Creating a materials policy

When creating framework materials policies, people north and south agree that we need to start by determining real, as opposed to created needs and the way in which these can be fulfilled. Needs, rather than goals, becomes the driving force of development and providing materials.

In this context development must aim not simply to raise material standards but also to improve the quality of life. Needs are not necessarily material. Needs (in the case of the poor) are commonly perceived as a lack (of resources, materials or monetary wealth) that should be solved by external processes such as aid and subsidy. On the contrary, said Max Neef, they should be viewed positively, as potential. Our need for subsistence impels us to develop ways of making food for ourselves; our need to be creative members of society is a positive urge to participate and interact with others. What communities and individuals require from external agencies to satisfy their needs both material and non-material is to be *empowered* to take control over their resources in the way that the Jabhua project in Madhya Pradesh unleashed the creative energies of those in the region.

Our needs must be defined within the capacity of our natural system to carry us and replenish itself. We are depleting in a mere 200 years minerals that have taken millions of years to form. In 1994, the Factor Ten Club called for a 90% reduction in energy and materials used. In its report, GEO 2000, the United Nations states that 'conspicuous consumption by the world's richest countries has to be cut by 90%'. All are agreed that we must not only reduce our rate of material consumption, but also rethink the way we cut our cake.

The back-casting element of the Dutch Sustainable Technology Development Programme (STD) attempted to define *projected needs* against the future scarcity of resources and the necessity of reducing pollution. Back-casting is a way of taking an arbitrary future date, estimating available resources and projected needs and then planning forward. If it is decided that cars and planes will not play a significant role in a sustainable future, the basic infrastructure that provides these activities will no longer serve its present purpose. The same applies to urban structures and living arrangements. [25, Van Grootveld] This is a radically different way of thinking than building infrastructure and

industry in expectation of needs, or, more likely, in expectation that needs can be created.

Redefining value

One of the reasons we are mining our earth dry and destroying our ecosystem, is the lack of 'value' we attribute to our finite resources and biosphere. This value could be financial, moral or social. A plastic cup, in monetary terms, costs less than a clay kulhud, yet one does irreparable damage to our earth while the other does not. One is produced with machinery and few people; the other involves networks of families in mostly rural environments. Why have we effectively chosen to subsidise one over the other? Because finite resources and environmental and social factors are not valued, which means in today's terms they are not factored into the market price of goods.

Addressing the difficult question of how we can value resources, Hawkens and Lovins argue that assigning *monetary* value to natural capital is not feasible for three reasons. 'One, many of the services we receive from living systems have no known substitute at any price – for example, oxygen production by green plants. Secondly, valuing natural capital is an imprecise and difficult exercise at best. Thirdly, just as technology cannot replace the planet's life support systems, so too are machines unable to provide a substitute for human intelligence, knowledge, wisdom, organisational abilities and culture.' While there may be no 'right' way to value a forest, a river or a child, the wrong way, is to give it no value at all. 'If there are doubts about how to value a seven-hundred year old tree, ask how much it would cost to make a new one?' [14, Hawken]

Furthermore, the way that we measure economic success, for example GNP, have no moral or quality parameters. When measuring economic activity it is mostly irrelevant what products are being made and sold, as long as 'growth' increases. Although in the north economies appear to be growing – the US GNP has increased by 2.5% per year since 1973 – it cannot be assumed that society as a whole is prospering because the index relied upon, the GNP, *only measures money spent not value received.* The definition of economic growth includes all expenditures, regardless of whether society benefits or loses. 'Growth includes crime, prison maintenance, dump fees, environmental cleanups, the costs of disease, oil spills, divorce, and

every throwaway object along every highway, and liquor sold to the homeless. When accepted economic indices so wildly diverge from reality, we are witnessing the tottering end of a belief system.' [14, Hawken] Hawkens and Lovins give the bizarre example of GNP being increased in the US by negative factors such as a man with AIDS who smokes cigarettes and who is severely injured in a car accident. This man (or US social services) will spend large sums of money on medical treatment. This expenditure is a cost that brings negative benefit to him individually and society generally but is registered as financial growth in GNP terms.

Natural capital, the quality of air, water and bio-diversity, is not measured. The value of a tree is not measured, until it is cut down and commoditised. GNP is a measure of throughput, and as such ignores societal values of cohesion and well being. The material throughput of plastics will be registered, while the self-sufficient bamboo house builder will be ignored. If the capitalist system is to function more accurately, then one solution is to define the 'ecological footprint' of a material. and reflect it in its market value.

The Ecological Footprint

In Canada and other parts of the world, there is growing use of a concept known as 'the ecological footprint'. An ecological footprint is calculated by totalling the flows of material and energy required to support any economy or subset of an economy. These flows are then converted to standard measures of production required from land and water areas. The total land area required to support a given activity or product is the footprint.

'Every product we consume has a hidden history, an unwritten inventory of its materials, resources and impacts. It also has attendant waste generated by its use and disposition. The amount of waste generated to make a semiconductor chip is over 100,000 times its weight; that of a laptop computer, close to 4,000 times its weight. One tonne of paper requires the use of 98 tonnes of various resources.' [14, Hawken]

By internalising environmental costs we can begin to price goods at a *more accurate cost*. This would make renewable and locally produced

clay kulhuds more accessible and cheaper to buy than a petroleum-based plastic cup. Bamboo sheeting and jute sacks would then be cheaper than the plastic sheeting used by urban jhuggi dwellers and polypropylene sacks used for cement or foodstuffs. It will not necessarily result in higher costs for industry or the consumer, especially in the long-term. By choosing more environmentally sound materials; industry would avoid the add-on costs of managing hazardous processing systems. With a better product design, they would avoid the costs of dealing with intractable wastes; by placing emphasis on modular design they would make it easier to dismantle products for repair and recycling. Overall, it would reduce the contribution of the public sector costs to environmental damage control and slow down the consumption of resources.

Government investment in providing for certain basic needs can lower other costs of resource depletion and waste management. For example, take the plastic water bottle. TERI estimates that the annual cost of ensuring that every Indian has access to clean drinking water is Rs12,200 crore. 'The provision of adequate sanitation accounts for around 60% of the abatement costs; investments in providing piped drinking water account for 16% of the abatement costs; and sewage and effluent treatment account for the remaining 24%. While these costs seem high in the aggregate, they are only about Rs130 per capita per year. This cost is several times lower than the cost individuals bear when they buy bottled mineral water or water purifying devices.' [19, Tata Energy Research Institute]

From goods to service

Since the European industrial revolution, economic activity has been mostly based on the sale or trading of material goods. With goods such as commodity plastics, where margins of profitability are thin and costs rise and fall in cycles, only the manufacture of huge volumes makes long-term profits possible. This encourages the throughput of materials into the environment.

Two things are required of a material product: a service (whatever the product offers) and profit from it, in order to make more of it. Many northern thinkers, including Hawken and Lovins and Tim Jackson, propose that we change our dominant material industrial paradigm to an immaterial one (service and flow), but still keep the profit to ensure the continuity of the service. 'The basis of this

reformulation is the transition from profitability based on the sale of material goods to profitability based on the provision of a service.' [22, Jackson] In a service economy, consumers obtain services by leasing or renting. The value is in the service and not the material. Leasing and renting encourages longevity and optimisation of material use.

If a material product is needed, then another set of criteria operates. The material should be sustainable, non-hazardous, durable, recyclable, etc. It should be the best material for the service in terms of performance and location.

Levelling the economic playing field would encourage a return to the age-old system of locally made products using renewable materials. The more universal a product, the closer to the community should be its production domain. Using local materials reduces energy and infrastructure costs. This is a material policy that enhances the social and cultural idiom of Gandhi's vision of swadeshi and networking proposed by Karanurakaran, and lies at the heart of self-reliance.

Our materials and energy in this case would be found from renewable sources. Bio-plastics are one material that could be used to replace many current commodity plastics. TERI is recommending government and private industry funded research that leads to, '(1) the development of biodegradable materials, (2) technologies that are low in energy intensity as well as harmful environmental impacts, and, in general, (3) the development of products and processes that are low in intensity of use of raw materials'. [19, Tata Energy Research Institute]

A place for plastic

As we progress towards a bio-based material policy, finite resources such as oil should be restricted to use in long life products of unique importance. Plastic material has a unique advantage in some high-tech applications. Certain types of engineering and technology require material properties that conventional and bio-based materials cannot provide. The Internet (that both aids material consumerism and de-materialisation) is encased in plastic. Plastics are often a key component of renewable energy technologies such as wind-generators and solar energy. Engineering plastics can help save other

materials, for example, one-piece mouldings that replace many machined or cast parts. In India much precious water could be saved by subsidised allocation of plastic sheeting to line canals and irrigation channels that supply water to subsistence farmers. TERI calculates than 45% of irrigation is wasted by seepage through unlined field channels and canals and another 15% wasted through over-application. Plastic has a role to play in saving water used for subsistence farming and perhaps in the regeneration of local-level traditional water harvesting.

In this sustainable scenario the petrochemical industry and its products would be sanctioned by a very different set of criteria. It would result in fewer and different kinds of plastic products – specialised, essential products, with properties that cannot be matched by renewable material or bio-plastics (although this could soon change).

The changing role of industry

If industry embraced these sustainable frameworks, then its operations and role within a community would change radically. Industry would take responsibility for the full life cycle of its processes and products. It would accept Extended Producer Responsibility (EPR) for products and wastes, taking back products at the end of their (hopefully long) lifecycle for repair and mechanical recycling. With the manufacturers of consumable durables offering a service rather than the sale of their goods there would be less plastic used, less waste and throughput of virgin resources would be drastically reduced. The waste management sector of a company would deal with all wastes arising from its products, and give the currently informal waste collection and recycling sector statutory health and safety protection rights.

As Walter Stahel emphasises, adopting the service paradigm reduces resource use and increases meaningful employment. Much more energy is required in extraction of virgin raw materials than in manufacturing processes. Many more people are required to manufacture goods than extract raw materials. Therefore, when products are designed to be re-manufactured then less energy is consumed and more people are employed. [254, Stahel]

A shift towards bio-based industries could radically change present industrial structures. Bio-based products are best manufactured close to sources of raw material. This could change the relationship of communities to their local resources, and their power within the economic structure. The technology of bio-based material

production is not necessarily capital-intensive, compared to mining minerals or oil exploration and extraction, although initial research and development costs are high.

Encouraged by legislation that favoured production of sustainable materials, industrialists would embrace concepts of eco-design to manufacture durable and long-life products. Instead of welcoming trade delegations from the MNCs India would seek international co-operation with sustainable product designers and intermediate technologists. It would look to manufacturing by means of a large number of small-scale industrial enterprises, rather than a small number of large-scale urban based plant – a policy that would revitalise rural areas and reduce migration to cities and subsequent strain on infrastructure needs.

How? Government and policy

As wildlife conservationist, Valmik Thapar commented on Gadgil and Guha's book 'Ecology and Equity': 'Nobody could argue with the philosophy of these strategies, but how on earth could this happen? Who creates and enforces an ecological agenda? Can anything work without 'a code of conduct' in ecological terms where all omnivores[13] follow a strict code of consumption and a new law is enforced for the ecological security of this country...There is a big gap between the India that is and the India that might be'. [255, Thapar]

We cannot hope to achieve radical change in the use of existing materials and the regeneration of renewable materials without embracing the economic, political, cultural, social, and technological implications. Such a change is bound to encounter institutional stumbling blocks and conflicts of interest. The emergence of any new material policy cannot occur without it being fully embraced by government, as well as industry and the general public. 'The environment is not an add-on extra. It is central to a sound socio-economic future and must move centre stage in every arena of policy, locally, nationally and internationally.' [256, Guardian Editorial]

[13] Gadgil and Guha see the social and environment crisis in India as a conflict between urban 'omnivores', the one-sixth of India's population who are the beneficiaries of economic development by devouring the resource of the earth, and the rural 'ecosystem' peoples, the majority of India's population who depend on the natural environment of their own locality to meet most of their material needs.

India has never been, and hopefully never will be, allied to any one economic system, to one religion or one political forum. It is not inextricably committed as the north is, and especially the US, to a single capitalist system. This is a society that contains within it Bihar Adivasis, Bangalore computer programmers, Tamil Nadu fisherfolk and Maharastran sugar barons, Himachal mountain Gaddis, Delhi's white-collar babus. Indians are politically ruled by Brahmins or Dalits, spiritually directed by a number of different creeds including Hindu, Muslim, Sikh, Jain, Buddhist, and Christians. There are at least 4,635 communities that make up the Indian population, speaking more than 50 languages. India subscribes to political ideologies that include two types of communism and a host of political parties within an Indian-flavoured democracy. It is perhaps unique in the world in that, couched in different names and meshed into different philosophies, there are various prototype economic systems that co-exist, sometimes comfortably and sometimes uncomfortably.

Gadgil and Guha describe three different economic systems existing in India (seen by them as contending philosophies) – Gandhism, Marxism and liberal capitalism. They argue that each 'has components that are very desirable from an environmental and social perspective. But each philosophy also has components that deserve to be decisively rejected'. What is needed, they say, 'is a synthesis of the several positive elements: decentralisation and empowerment of village communities along with a moderation of appetites for resource consumption from Gandhism; equity and empowerment of the weaker sections from Marxism; and an encouragement of private enterprise coupled to public accountability in an open, democratic system from liberal capitalism'. [26, Gadgil and Guha]

India is proud of being 'the world's largest democracy'. Democracy is supposed to provide mechanisms for making collective decisions that serve the best interests of its peoples. Citizens elect representatives who gather to make decisions on their behalf by the process of bowing to the will of the majority.

Table 30 Comparison of the characteristics of different economic systems using several criteria of significance.

Criteria	Free Market: Western Economy	Centrally Managed Economy	Eco-Social Market Economy
System conception	Capitalism	Communism	Sustainable world condition
World view	Mechanistic	Mechanistic	Ecological, cybernetic analogic
Ethics	Egoism; individualism	Marxism; socialism	Holism; communalism
Features	Competition	Regulations	Co-operation and competition
Objective	Profit	Equitable distribution	Harmony with ecosystem
Property	Private	Public	Private and public
Metaphor	Jungle	Puppet	Sustainable life
Problem solving capacity	Local planning, economic laws one-sided	Central planning; constrained by ideology	Regionalised, evolutionary, autonomous, self-organising
Priority	Economic efficiency; ecological exploitation; social inequity	Social equity; ecological exploitation; economic inefficiency	Ecological security; Social equity; Economic efficiency; technical feasibility

Source: [223, Moser]

Strong central government

Wise governance is the key for any transition to a sustainable society, working in partnership with both industry and citizens. For this India needs a strong, visionary central state. A state strong enough to withstand the pressures of the northern multinationals and their industrial allies in India, who knock at its doors, begging to create more needs, and exploit its relatively un-needy market. A state that sees that the economic model it has embraced will lead to further social inequality and dislocation. A state that accepts that finite resources are limited and is prepared to plan for other ways to provide basic material goods. A state that has the vision to nurture

India's bio-diversity, tradition, culture, and social networks. A state that understands and acknowledges the true needs and wants of its people. (Even for competitive capitalist enterprises, according to Hawkins and Lovins, the best long-term environment for commerce, 'is provided by true democratic systems of governance that are based on the needs of people rather than the needs of business'. [14, Hawken]) A state that is prepared to be flexible and confident to legislate and implement laws needed for change. Sachs considered it of 'secondary importance whether the streamlining of industrialism will be achieved, if at all, through market incentives, strict legislation, remedial programmes, sophisticated spying or outright prohibitions. What matters is that all these strategies call for more centrism, in particular a stronger state'. [23, Sachs]

Who? The Planning Commission

As governments have come and gone, some of the socialist tradition in India has remained in the Planning Commission, responsible for formulating the series of five-year plans for the economy. This is the authority that potentially could create a sustainable materials policy for India. There needs to be changes in its constituency and approach. In particular the scope of its remit should be widened from its present limited economic bias since economic issues cannot be separated from the environmental and social. The Commission needs to draw upon sources other than economists, technocrats and civil servants for strategic advice and information. It needs to open the planning process to a wider range of government departments and vested interests, including citizens' organisations. TERI acknowledges this: 'Essentially, unless local institutions are created that can come face to face with reality at the very grass-roots level, the echo between ideas based on change at the national level, however enlightened and brilliant they may be, will fail to evoke a response that provides matching logic at the grass-roots level. In the ultimate analysis, the motivation for change can only come if this becomes a part of the political agenda.' [19, Tata Energy Research Institute]

Legislation

Evolving a sustainable materials policy in India will require, as elsewhere, a major adjustment of mind-set and a radical legislative agenda. It would need to be innately flexible to cope with the speed of change.

Traditionally, for hazardous industries, environmental regulation has meant setting levels on the amounts of pollutants to be discharged. This has led to the limited end-of-pipe approach to environmental protection, currently employed in India. Such a system burdens industry with add-on costs, reducing efficiency and competitiveness. In the north there has been a shift away from merely controlling pollution to preventing it by a 'carrot and stick' approach. Legislative options available to governments aim for the long-term benefit of cleaner, sustainable industrial processes and products. For example, economic instruments such as differential taxation and active subsidies can be employed to value and promote sustainable industries/products and at the same time to penalise resource intensive and environmentally harmful processes and products. The implementation of regulations can be incremental, so as not to create immediate social dislocation and to allow time for economic activities to be changed

The value of natural resources is currently distorted by subsidising destructive practices, (for example, in agriculture, energy production, the military sector, transportation, water, forestry, fisheries and industry and mining). These subsidies are 'concealed or brazenly defended as pro-growth and pro-jobs by the powerful interests who benefit from them but are seldom revealed clearly or directly to the taxpayers and community who finance them'. [14, Hawken] Other subsidies are 'perverse', and, like the Government of India's subsidising of jute mills, do not bring long-term benefit to an industry. Slowly in the north attempts are being made to change taxation and subsidies. This means taxing pollution, waste, carbon fuels and resource exploitation instead of labour. It means subsidising clean technologies, investing in renewable materials and encouraging movement away from economies based on material throughput to emphasis on services.

Devolvement

Perhaps the most radical and historical change required of government policy is its attitude towards the devolvement of power.

One challenge for government is to encourage genuinely open participation in planning for a sustainable future. The problems involved in bringing about any paradigm shift are the problems of

changing any orthodoxy – of winning acceptance of ideas that seem to challenge accepted wisdom. Steps towards this include creating awareness of the issues, arguing the importance of change, discussing the feasibility of change, creating an interest in alternatives and a desire for change.

A first and vital step towards open government has to be 'Right to Know' legislation, whereby planning information and primary socio-economic data is freely available to all. Much of the polarity that has developed within the last few decades between citizens/environmentalists and industry/government in India is due to the withholding of information, the secrecy and lack of partnership that the government habitually practices. Government is traditionally reticent to open up its decision-making processes since the public is perceived as a potential hindrance to the rapid execution of development projects. Open government would permit discussion of social and economic priorities and be the start of a consensus building process that could lead to development that fulfils the needs of all. Potentially Internet could force the closed doors of Government to open further.

Sustainability cannot be achieved just by regulating and changing the economic system. Social reforms are necessary. One crucial need is land reform, a giant of an issue in India. Sustainability can only be achieved when there is more equitable ownership of cultivable land. Once rural communities and individuals are *empowered* to provide for their own needs they will, in the process, preserve and nurture bio-diversity.

Sustainable development cannot be delivered by an agency that represents a national or international alliance of political and economic powers. Sustainable development has to be what human communities do for themselves. It cannot be implemented according to a managerial blueprint in which the majority of the people have had no say.

> 'Development geared to the satisfaction of fundamental human needs, cannot, by definition, be structured from the top downwards. It cannot be imposed either by law or decree. It can only emanate directly from actions, expectations and creative and critical awareness of the protagonists themselves. Instead of being the traditional

> objects of development, people must take a leading role in development.' Max-Neef (1991) quoted in [217, Reid]

A self-reliant community, be it local, regional or national, defines the satisfiers for its 'needs'. It does not succumb to the globalised satisfiers that can so often lead to a pseudo satisfier that leads to a spiral of consumerism. It relies on its own resources, the fruit that is within season, the material that is close by – all in plentiful supply and replenishable. Bio-based materials are more equitably distributed and fit well within a self-sufficient community. The community maintains the system, for that is itsvested interest.

Since Independence, there have been spasmodic attempts to decentralise political authority and create democratic institutions at district (zilla) and village cluster (mandals) level. 'All over India such institutions have been set up but almost always they have been undermined by an alliance of state and national-level politicians and government officials.' [26, Gadgil and Guha] The success of the watershed management programme in Madhya Pradesh where environmental regeneration provided the framework for economic well being is attributed to power being given directly to the people by the State Government encouraged by the Chief Minister, Digvijay Singh. It remains to be seen if this success will lead to greater and more meaningful participatory government elsewhere in India.

Obstacles to change

A good number of India's billion citizens would roar with laughter at the idea of its government even contemplating an agenda that would break with the prevailing paradigm, invest in renewable sustainable technologies, devolve power, open its information files to public scrutiny or legislate for a sustainable society. Novelist Arundhati Roy is scathing about the Indian State:

> 'It's time to spill a few state secrets. To puncture the myth about the inefficient, bumbling, corrupt but ultimately genial, essentially democratic, Indian State. The Indian State is not a state that has failed. It is a state that has succeeded impressively in what it set out to do. It has been ruthlessly efficient in the way it has appropriated India's resources and redistributed them to

a favoured few (in return no doubt for a few favours). It is superbly accomplished in the art of protecting the cadres of its paid-up elite, consummate in its methods of pulverising those who inconvenience its intentions. But its finest feat of all is the way it achieves all this and emerges smelling sweet.' [13, Roy]

Currently there is no strong central government in India. India is going through a period of short-lived governments, which can only function by making alliances with vested interests and factions within the various states. The central unifying power of the Nehru dynasty's Congress has become fragmented. Arguably this indicates the growing maturity of India's democratic tradition, in that the Brahmin elite has been challenged by 'developing caste' leaders thus reflecting the social and cultural diversity of India. But factional scrabbling for slices of the national cake does not help provide a coherent vision of a sustainable more equitable future for all. The democratic process in India, as elsewhere, has become an example of Max-Neef's description of formal democracy as a pseudo-satisfier, only seemingly satisfying the need for participation. The sad fact is that even the smallest tokens of change are seen as the gift of a political party rather than part of the rights of citizens in a democracy.

Disenchantment with Government

Governance in India reflects a general global debasement of democratic processes. To get elected 'candidates develop techniques for exploiting the gap between promises and actions...The process deteriorates further when the voters cease to care whether their candidates cheat and lie as long as they represent the voters' personal interest. Ultimately the electorate no longer expects candidates to be honest, but judges them purely on their ability to get elected'. [251, Soros]

In India, an anti-incumbent factor now operates. Those elected for parliamentary duties are now expected to concentrate on serving their own interests during the life span of the parliament, and are not then re-elected. In the national elections in September 1999 at least 220 seats of the 537 in the Lok Sabha changed hands. In all but 2 of India's 25 states and 7 territories the incumbents were voted out. [257, Goldenberg] The public is understandably cynical, and has low expectations of government policy or action.

As in other countries, the process of planning the socio-economic future of India has so far been somewhat haphazard and short-term, caught between conflicting interests both inside and outside government.

While Indian politicians dress in Gandhi's home-spun khadi their actions are the opposite of what their clothing mentor envisioned. The current government, the Bharatiya Janata Party (BJP), the party of Hindu fundamentalism, pays lip-service to the Gandhian idea of 'swadeshi' or self-reliance: on their Internet web pages swedeshi translates into promoting Indian ownership of MNC operations in India. [68, Diwan]. The Gandhian ideal of swadeshi has been lost by the political elite and there is no alternative vision to the northern paradigm and growth economics.

The promise of the 'trickle-down' effect has an obvious appeal for political leaders in inequitable societies: it profers all the potential benefits from growth without disturbing the status quo, and without threatening the power and privileges of the better off. 'The vision that growth conjures up of an expanding pie of riches is a powerful and convenient political tool because it allows the tough issues of income inequality and skewed wealth distribution to be avoided.' [217, Reid]

Government clings to power and authority and uses any means available to stifle opposition. Those protecting the land-rights of the poor, when they face total deprivation from 'development' projects, are reviled as enemies of the state. They are sometimes lathi-charged by police into submission or, if they have power and influence, become the victims of smears and dis-information campaigns.

Vendetta against criticism

The Indian State, as many others, changes slowly and reacts defensively to criticism, especially from foreign sources. Arundhati Roy has published long and impassioned attacks on the Indian nuclear tests in the Rajasthani desert in May 1998, and more recently has attracted criticism for campaigning against the construction of the Narmada dams in India. Her articles have been published abroad and her stance has led the authorities to mount a 'vendetta' against her, which has been admitted by at least one government official. Roy described it as ' a case of dirty tricks. It is standard practice in India. The minute you make a fuss they find a way of getting to you to shut you up'. [258, Burke]

One potent obstacle to change is *denial*. Individually and collectively we share a capacity to refuse to face the seriousness of the crisis, preferring to ignore reality rather than accept the need to change. Denial is the most powerful defence mechanism. 'We deny the seriousness of the situation, afraid to admit to ourselves that prevailing practices are wrong or inappropriate, and are even more obstinately defensive when others confront us with evidence of the need for some amendment of our normal ways.' [217, Reid] Mary Midgley of the Gaia foundation describes denial as a consequence of being outside our existing concept.

> 'This crisis is, quite literally, something new in human history. People have never before faced a situation where they found themselves endangering the whole natural system that they depend on – not just locally but planet-wide. This state of affairs is so far from what we are used to expecting that our existing conceptual schemes – centred on human independence and grandeur – cannot accommodate the change. We therefore tend to ignore it, going into cognitive dissonance and continuing to cultivate our previous idealisations, such as economic growth, personal autonomy and the social contract.' [259, Midgley]

Another limitation is the feeling of *impotence*, of being trapped in a destructive spiral that is uncontrollable by the individual. This is a feeling common to many, both north and south, with regard to our ability to influence economic and political decisions that can shape all of our lives. The large multi-national organisations and trade organisations who affect the lives of the farmer in Orissa and the potter in Lucknow from their headquarters in the financial capitals of the north, appear too remote and enormous to challenge. Bakshi concludes: 'At the threshold of the twenty-first century, the idea of challenging the Wall Street concept of 'market' and redefining progress may seem ridiculously ambitious. The idea of a different kind of 'globalisation' a process of international co-operation that gives primacy to local self-reliance, appears like an outright fantasy'. [27, Bakshi] Ronald Higgins points out that 'the inertia of governments derives in large measure from the self-imposed helplessness of individuals'. [260, Higgins]

Perhaps the most insidious obstacle to a change of values is the immense global power of marketing and the creation of perceived needs. The separation of government and the media from business has become muddied. Politicians can be convinced or 'bought' by business to promote material growth as being necessary for the general 'good'. This gives a clear field for business to use any available mechanism to flood our minds with the necessity of buying their wares. Advertising on billboards, in newspapers and magazines, on radio and television, unconsciously conditions the behaviour of us all. The media not only sells consumerism but at the same time debases the values of simple sustainable existence. As subsistence economies become cash economies, Bollywood and Hollywood and the popular music industry promote consumer lifestyles, potent dreams that define success as the acquisition of material trappings.

The march of the monoculture

> 'The one-dimensional, fantasy view of modern life promoted by the media, becomes a slap in the face for young people in the 'Third World'. Teenagers, in particular, come to feel stupid and ashamed of their traditions and their origins. The people they come to admire are all 'sophisticated' city dwellers with fast cars, designer clothes, spotlessly clean hands and shiny white teeth. Yet they find their parents asking them to choose a way of life that involves working in the fields and getting their hands dirty for little or no money, and certainly no glamour. It is hardly surprising, then, that many choose to abandon the old ways of their parents for the siren song of a Western material paradise.' [261, Norberg-Hodge]

We may need to experience further environmental devastation before we are convinced of the need to change – especially those of us who have benefitted from the system in materially rich communities. Our climate may have to change radically, and create more loss of life and social disruption. India, as evidenced by unusually severe floods and storms in Gujarat in 1998 and Orissa in 1999, is on the frontline of these effects. Plastic products may have to proliferate until they eliminate traditional bio-based products. Urbanisation may have to choke cities further. Fertility may have to fall owing to estrogenic chemicals (among the most potent from plastic production) awash in all of our bodies. More lands and resources may have to be appropriated in the interests of global

industry. Future conflict (which many predict will inevitably happen because of resource depletion and control of resources such as water) and socio-economic catastrophe can only be avoided if we realise how critical the situation is, and take individual and collective actions.

Because it is the north that has set in motion this spiral of 'consume and be happy', some, like Ullrich, argue that it is up to the industrial northern countries to start an 'industrial, technological and economic 'disarmament''. It is up to the north to decelerate material production processes. It is up to the north to change the cultural paradigm. Soros argues the same: 'Only those who are successful in the competition are in a position to institute changes in the terms on which the competition is carried on'. [251, Soros] Back to Maslow's hierarchy, the north has, in its way, 'satisfied' its physiological needs and has the luxury of contemplating the mess.

However, in the north people generally believe that new technologies yet to be created will make possible a continuation of precisely the same prosperity (or increase it), satisfying the same needs and wants as the old technologies did. And if we run out of space and resources? Other planets can be mined for minerals; huge satellite mirrors will reflect the sun's energy. We do not have the answers yet, but as the oil runs out we are confident that technology will provide. And if the financial markets impound, come crashing down, their plastic casing melted, 'the current spending boom would probably come to a rapid halt, but the underlying technological and political forces that are generating an increasingly non-egalitarian society would not be much affected'. [21, Cassidy]

At the start of the 21st century the world's economy appears to be held together by the shopping abilities and material consumption of the United States. Its citizens now consume more than 5 trillion dollars worth of goods and services each year and are deeply in debt. Because of excessive spending, over one and a half million people per year in the US file for personal bankruptcy. 'With so many people going bankrupt when the economy is doing well, it is frightening what might happen in a downturn.' When Japan suffered financial crash in the 1990s, over 3,500 people took to the woods beneath Mt Fuji to commit suicide. The Financial Times, Europe's leading business newspaper, recently referred to the US as the industrial

world's 'consumers of last resort' and urged them to keep on shopping in the interest of global prosperity. Once on the spiral of competitive materialism people have to consume at faster and faster rates to maintain their position relative to others.

Change

The northern industrial paradigm is not foisted without acceptance upon a helpless population, but a structure we have become conditioned to accept. It reflects current values and will change as individual values change. Unless we subscribe to a fatalistic, deterministic view (which the prevailing paradigm encourages us to adopt in many insidious ways), we *can* change social and political arrangements to bring them into line with new perceptions and values.

Change is only possible if we feel it is possible. Change needs to happen inside human beings and not a reaction to or dependence on external events and manipulation. Ultimately it is not the economic system that controls our lives, but we who determine the nature of the economic system by our individual and collective choices. It is not technological advance that dictates change, but we who choose how technology will be applied. Our choice will reflect our values.

> 'It is no longer the 'we are here and the system is there and we have to do something about it, so let us devise a strategy that may solve the problem'. It is rather the 'we are part of something that has to be transformed because it is wrong, and since I share the responsibility for what is wrong there is nothing that can stop me from starting the process by transforming myself.' Max Neef in 1991

Potentially, India is better placed than many other societies to make the transition. Although it appears crippled by poverty and a rapidly expanding population, these problems are mostly caused by inequality rather than technology, by the distribution of resources and political games rather than the lack of food and goods. India remains a largely agricultural society, with a strong cultural attachment to community and tradition. The industrial revolution is not so deeply embedded that it is inconceivable to undo its negative impacts. India is not yet so handicapped by energy-intensive heavy

industry to make impressive leapfrog advances in sustainable, efficient energy systems. As UNEP states, 'Cleaner production is now especially attractive to developing countries and those undergoing economic transition because it provides industries in these countries, for the first time, with an opportunity to 'leap-frog' over older, more established industries which are still saddled with costly pollution control technologies'.

India's elite has only recently become enamoured with material consumption. As part of its powerful religious and spiritual traditions, renunciation of material values remains important in India. There is significant distrust of the ways of the north and vociferous grass-root opposition to the entry of MNCs. Political leaders have protected some aspects of India's economy from globalisation. For example, keeping India's currency out of the global markets, thus avoiding the worst of South East Asia's late 1990s economic collapse, (though they showed less foresight in joining the WTO which is clearly designed to bring most benefit to the global corporations and trade blocks in the north.)

With its vast bio-diversity India could be in the forefront of the carbohydrate technology revolution. India still has the rich human knowledge of natural systems that the north lost long ago and is trying now to resurrect. It has the landmass and climate to grow the crops, the resource base, for the new carbohydrate revolution. It has the men and women power to work this system, to devolve from the mega-cities to the rich landscape. 'To conserve this most important natural heritage,' TERI said of its native bio-diversity, 'we need to involve players at the grassroots, build research institutions with impeccable credentials, and negotiate for fair terms at the international level with multi-national firms.' [19, Tata Energy Research Institute] Yes, India needs to protect, invest and develop these potentials.

For all its inadequacies, India's democratic process offers potential for change - not from top-down leadership but from the fact that any democratic establishment has to listen to the demands of its people to survive. Even though governments try to shape opinion to serve their own agenda, ultimately political priorities will reflect individual and collective choices and values.

Professor Diwan believes, like many, that it will be the people who continue to recognise the differences and demand change:

> 'It is not accidental that the large part of the Indian population has rejected the government promoting such reforms[14]. People at large have wisdom. They can, and do, distinguish between myth and reality. They yearn for an alternative based on reality and not a myth. Gandhian ideas of swadeshi provide such an alternative: that is integrative not divisive, where there is personal integrity, quality of character and commitment to public good instead of corruption; that exalts, strengthens and stabilises and not destroys, family and neighbourhood, mohalla, and village.' [20, Diwan]

There is a vibrant environmental movement in India. The movement has grown rapidly in the past two decades. 'Indeed it is the protests of environmentalists rather than the concerns of the state or intelligentsia, that have generated a wide public awareness of the extent of environmental degradation in India and (what is more important) of its human consequences.' [26, Gadgil and Guha] The networks that Karunakaran spoke of are growing in India, as elsewhere, broad-based networks of urban-educated *and* marginalised rural peoples united in opposition to further destructive development, with a common vision of a sustainable future based on decentralised power structures. Increasingly in the last few years, environmentalists have built alliances with the 'ecosystem peoples' to forge national movements that respect cultural, social and religious diversity.

Educating and empowering those affected by 'development' projects creates powerful forces. Claude Alvares' Goa Foundation helped prevent Du Pont building a Nylon 66 factory in Goa. He attributed the success of the campaign to the slow process of informing those who would be affected by the factory about the precise chemical hazards their water and land would be subjected to. Technical consultants and civil servants employed by industry and government were no match for well-informed rural peoples protecting the future of their community.

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[14] Ironically Diwan is referring to the rejection of the Enron deal, that subsequently went through.

The internationally renowned environmentalist, Vandana Shiva, has built alliances with a cross-spectrum of concerned citizens to form a movement called Jaiv Panchayat – Living Democracy. Their main focus is stopping the World Trade Organisation's (WTO) 'bio-piracy' of Indian's bio-diversity and indigenous knowledge through the 'Agreement on Trade-Related Aspects of Intellectual Property Rights' (TRIPS) that allows foreign companies to patent Indian bio-species. The campaign emphasises the decentralising of democratic rights. Urban intellectuals and lawyers distribute information, often through electronic networks, to mobilise and facilitate the direct involvement of rural peoples (who often have had no access to formal education) in international processes. Permanent People's Tribunals (PPT) regularly hear cases by individuals or communities affected by environmental degradation.

Through the plastic-encased Internet, huge networks of public interest, environment, human rights, consumer development, religious and umbrella civil society groups, drawing in local, national and international organisations, are beginning to emerge. For the first time they are able to respond immediately to international events, counter state propaganda or bring concerted pressure to bear on governments, companies or international bodies. The inequality of WTO policies, particularly with regard to the resource-rich south, was laid bare over networks throughout the world, culminating in strident opposition to the WTO agenda at their Seattle meeting December 1999. The US military calls these 'social netwars'.

In 1999 the world's most powerful military machine commissioned a series of papers from the Rand Institute, a leading US government-funded think-tank. The papers argued that 'the information revolution now sweeping through most countries is migrating power away from nation states towards new non-government alliances and networks of civil organisations. The implications for the way societies develop and the foreign policy of governments may be huge, and the threat to established, but particularly authoritarian, regimes may be significant'. [262, Vidal]

Social netwars and World Trade Organisation

Concerted action against the WTO in December 1999 in Seattle, US, caused the talks to collapse in disarray. Hundreds of diverse groups, often not even present in the city, massively opposed an organisation that few people in the world had ever heard of, let alone thought about. Through a concerted information campaign and public protest, they raised a global debate questioning the very legitimacy of the WTO. They set an agenda of public disquiet that shocked many northern governments. Perhaps more importantly, they gave strength to many poor countries whose delegations arrived at the talks prepared to be sidelined. For once development policies were not subservient to free trade policies.

Even within the institutions that underpin the current economic world order, we can see evidence of changing values. The concept of development based on monetary values, in which wealth would trickle-down to improve human welfare, is giving way to much broader definitions. 'UNDP has focused on human development and issued a series of Human Development Reports exploring critical issues such as gender inequality, growth, poverty and consumption patterns. The World Bank has expanded its definitions of wealth to include 'produced assets', natural capital and human and social capital, with the latter generally being the major component of national wealth.' [211, UNEP]

North and south, east and west, there are pockets of people who are redefining 'progress'. From the people pursuing Gandhian ideals to the multi-billionaire George Soros with his Open Society Foundation. These pockets of resistance are becoming more and more mainstream, changing aspirations that energise many thousand activists. They start by questioning prevailing values and assumptions.

If we re-look at our example of the plastics industry, at the historical context of its inception and growth, we can see how plastic was integral to the expansion of materialism in the US and the north. How industry had to create markets for the multiple varieties of materials it was discovering. By promoting the plastic industry in India the government is not only embracing an economic paradigm, but a value system and culture. The first step towards building an alternative world has to be an awareness of the values behind any

culture. We have to understand the assumptions that underlie so-called facts and truths. Many plastic products are not 'essential' for our well being, although some have their uses. They often do not benefit all but threaten the livelihood, health and sustainability of large numbers of people. The science that supports its environmental safety is not necessarily 'sound' and independent but can be bought and sold. Government regulations do not protect workers and the community from chemical hazards created by the production, processing and reprocessing of plastic.

> 'First a horizon has to be discovered. And for this we have to find hope – against all the odds of what the new order pretends and perpetrates. Hope, however, is an act of faith and has to be sustained by other concrete actions. For example, the action of approach, of measuring distances and walking towards. This will lead to collaborations that deny discontinuity. The act of resistance means not only refusing to accept the absurdity of the world-picture offered us, but denouncing it. And when hell is denounced from within, it ceases to be hell.' [263, Berger]

Let's put this into perspective. The Plastic, Age, like the Bronze Age, is not an eternal state. The whole-scale institutionalisation of the profit motive was born in the European Age of Enlightenment, blossomed during industrialisation, and has only been dominant in the last two to three hundred years of a very long human history. All civilisations pass. The threats now posed to the very existence of our planet are already preparing for the coming of a new age.

In December 1993 at the Mumbai IIT C.V. Seshadri welcomed delegates to the first Congress on Traditional Sciences and Technologies:

> 'Science is about models of reality and technology is about these models of reality actualised in man-made processes of home, agriculture and industry. Conversely, civilisational realities can be perceived through arts, artefacts, and manufacturers.
>
> The 6,000 years of (India's) civilisational continuum, representing an unbroken science and technology tradition stretching from agriculture to architecture, to

> animal husbandry to water management, to industry to health care, to theoretical sciences – is real. That it remained an object of ecstatic admiration by other civilisations for over thousands of years is also real. That till about 1750 (this tradition) produced 25% of the manufactured and traded goods of the international market is also real. And all this cannot be written off either as an accident of history or as aberration of human recording.
>
> That she (India) ceased to matter in the global context during the last 200 years is perhaps the most unfortunate event which we all must learn to erase from our memory... That the social formations which produced these marvels of yesteryears are still alive and living and can be rejuvenated is true and beyond doubt.' [27, Bakshi]

Change is possible, indeed necessary, but we must want it. The next age has to be one of sustainable carbohydrates in which we are not separate, independent autonomous entities but part of the circular balance of systems. Where we evolve an economic and social system that values our natural capital, nature. Where our material needs are fulfilled in a sustainable way, using the renewable materials of nature in ways that respect cultures and peoples.

The overwhelming majority in the world, and two-thirds of the Indian population, still shape and satisfy their needs thanks to the network of human relationships they preserve within their communities. Their material needs are fulfilled in sustainable ways. We could respect and emulate these traditions – or we could continue to dismiss and 'conquer' in favour of modernity, globalisation and consumerism, until the last drop of oil is gone.

Annex 1 Background to the Rigo report

In 1995, Greenpeace obtained a copy of a Vinyl Institute (VI) internal memorandum with an attached plan entitled 'Crisis Communication Protocol for the Vinyl Institute'. The memorandum was circulated to the VI's executive board on September 6th, 1994, one week prior to the scheduled release of the Draft Dioxin Reassessment Report by the US Environmental protection Agency (EPA). It defined VI's 'long-term goals of crisis communication' as follows:

'To avoid deselecting by major PVC customers

To prevent punitive regulation of PVC

To aggressively defend the industry's credibility through the use of third party sources to debunk Greenpeace's – or even EPA's – misleading claims.'

This is where Rigo enters the picture. The VI bought Rigo in to serve in a role that might be described as 'VI's designated third party'. The third party's role, as defined in the Crisis Communicaiton Protocol, was to debunk the anticipated conclusion in the EPA report on dioxin, 'that the incineration of chlorine compounds is the single largest known contributor of dioxin'.

The way this was achieved was described in another memorandum dated August 22nd, 1994 from Don Goodman, chairman of VI's recently established Incineration Task Force. The Goodman memo begins: 'The Vinyl Institute has created an Incineration Task Force in anticipation of adverse EPA actions regarding dioxin and furans. After the dioxin reassessment, we believe EPA will focus on dioxins from incineration, particularly the incineration of municipal waste, hospital waste, and plant industrial waste containing (high) levels of PVC.'

Membership of this small working group included representatives of Geon, Dow and Oxychem, three of the largest US producers of PVC and its feedstock chemicals. (Geon - previously B.F. Goodrich - is a major business partner for technology and feedstock sales with India's largest polymer producers.) The Chlorine Chemistry Council of the Chemical Manufacturers Association was also represented.

Dick Magee, an accademic member of the Incineration Task Force, was the author of a 1989 study for The Society of Plastics Industry that had found no link between PVC and dioxin emissions from municipal incinerators. Within VI, Magee earned the title 'Lead Contact' for incineration projects according to an August 1993 VI Status Report. He also served as an active member of ASME (American Society of Mechanical Engineers).

According to Goodman's memo: 'Dick Magee brought forward a proposal from ASME to hire Rigo & Rigo Associates, Inc. of Cleveland, Ohio. The purpose of ASME, as the contractor, is to provide unassailable objectivity to the study. The ASME oversight and review committee will bring independent reviewers (including EPA members) and high level peer reviewed documentation and reports'.

The memo goes on to state that the VI Incineration Task Force: 'interviewed Dr. H. Gregory (Greg) Rigo, principal of Rigo & Rigo Associates, Inc by phone and found him to be extremely knowledgeable...He is also user friendly (i.e. willing to set his priorities to our needs) and appears to be sympathetic to plastics, vinyl, PVC and chlorine.' In discussing the amount of money VI would need to pay Rigo and ASME to perform the study, Goodman clearly implied in his memo that working group members already assumed that Rigo's study, when completed, would reach conclusions in support of VI's objectives. [200, Costner]

Annex 2 Greenpeace Play Safe campaign

The Greenpeace 'Play Safe' campaign began in 1996 when Greenpeace wrote to major toy manufacturers all over the world enquiring about the materials used in toys. There followed a series of meetings with the International Council of Toys Industries (ICTI), where Greenpeace outlined both the overall environmental problems with PVC and the direct health hazard that soft PVC poses. Despite this, ICTI refused to disclose information about the materials used in their products, or look at alternatives to soft PVC. Instead they allied themselves with the PVC industry. In turn individual toy companies followed the ICTI line.

In 1997 Greenpeace started its own investigation into soft PVC toys. A total of 71 toys were purchased from 17 countries, including 5 from India, and analysed at Greenpeace Research Laboratories at the University of Exeter in the UK. Of these 71, 63 were made of soft PVC or had soft PVC parts. Almost all were found to contain significant quantities of phthalates. Extraction and analytical procedures were carefully quality controlled using a USEPA method for the analysis of phthalates. [139, Stringer]

European Commission Passes the Buck

In October 1997, the issue of phthalates in soft PVC toys was taken up by the European Commission in order to deal with the problem on an European Union (EU) wide basis. The Consumer Health Protection Services asked the European Scientific Committee to examine the evidence. Their first full opinion in April 1998 concluded that there were reasons for concern that infants could be exposed to unacceptably high levels of two phthalates, DEHP and DINP. EU Commissioners agreed that long-term regulatory action was needed to address the problems of phthalates.

On June 10th 1998 the EU Commissioner for Consumer Affairs, Emma Bonino, proposed an emergency ban on soft PVC teethers and imitation fruits containing the two key phthalates, DEHP and DINP. She failed to get the necessary majority by one vote. The Commission expressed concerns about scientific uncertainty with regard to the exact quantity of phthalates likely to leach out of a particular toy. They hoped this would be clarified by a Dutch study, designed to establish a standard and validated test. (Dutch Consensus Group Report, 'Phthalate Release from Soft PVC Baby Toys', editor W.H. Koneman, September, 1998).

Despite the uncertainty, Denmark and Sweden joined Austria in proposing an outright ban on the use of phthalates in soft PVC toys, taking the position that any possible exposure of children to hazardous substances is unacceptable. Two weeks later Emma Bonino returned with a further proposal recommending EU member states to take appropriate action themselves.

Toy Companies Take Steps

At the same time, Greenpeace and consumer groups called for an emergency ban on soft PVC toys. The first signs of the campaign's impact on the big US toy manufacturers came a year after the launch of the Greenpeace study. On September 23rd 1998 Mattel, the world's biggest manufacturer of toys, announced that it would phase-out phthalates in toys intended to be put in the mouths of children under three, from 1999.

The announcement coincided with the results of the Dutch study, which, 'weren't as reassuring as the plastics industry had hoped'. The study failed to establish a standard test that could be used to regulate soft PVC on 'safe limits'.

In November 1998 the issue hit the headlines in the US and Canada. Several other companies announced a phase-out of phthalates, including the giant retailer Toys R Us, which announced it would be withdrawing direct-to-mouth soft PVC toys from its stores world-wide. Another US company, Rubbermaid (Little Tikes) announced that they would phase out PVC entirely. In Canada the Federal Ministry of Health (Health Canada) issued an advisory which called for soft PVC teethers and rattles to be removed from shop shelves and called on parents and childcare facilities to immediately dispose of these toys.

In December 1998 the US Consumer Product Safety Commission (CPSC) released the results of a long awaited study on phthalates in soft PVC toys. The study concluded that few, if any, children are at risk, but it assumed that children would chew toys for a maximum of only 12 minutes. Nevertheless, the CPSC requested industry to remove phthalates from soft rattles and teethers. The CPSC reported that 90% of manufacturers indicated that they had, or would have, removed phthalates from soft rattles and teethers by 1999.

Although the CPSC confirmed the toxic hazards posed by phthalate plasticisers, Greenpeace expressed concern that these limited steps would not protect children from the hazards of soft PVC in other toys, such as squeezy ducks and bath toys, and toys for older children. By removing phthalates and not phasing out PVC itself, the toys industry left the door open for other equally hazardous additives to replace phthalates. Italian toy company Chicco, the world's number three manufacturer of toys for infants, announced in November 1998 that they would phase out the use of all soft PVC for toys made for under threes, joining LEGO, Brio and Ambi.

EU Ban revived

In November 1998, the European Scientific Committee (EU SCTEE) reviewed its opinion of April and reconfirmed the hazards posed by soft PVC toys. Greenpeace and consumer groups called once again for an emergency ban on soft PVC toys, but the political will to enforce a ban in the run up to Christmas was lacking, letting toy manufacturers and retailers clear their stocks of soft PVC in the Christmas consumer rush.

However, in the US, the government finally started to act against phthalates. On December 21st 1998 in a letter to 28 members of Congress, Vice President Gore (on behalf of President Clinton) announced steps to have relevant government agencies investigate the hazards of phthalates in PVC toys. In addition, efforts by US toy manufacturers to enlist the aid of their government to put pressure on the EU to resist banning phthalates backfired. A letter from Vice President Gore was obtained by Greenpeace and published by the media; 'I have made it clear that the Departments of Commerce and State should refrain from any actions to discourage individual countries, whether in the European Union or elsewhere, from implementing precautionary measures they deem appropriate to restrict the marketing or use of products containing phthalate[s].'

This led in January 1999 to the EU reviving its intention of banning phthalates. On the 1st of February 1999 the EU Industry Commission proposed a permanent restriction on soft PVC toys, covering toys and childcare articles intended to be put into the mouth by children under three years old, specifying an unlimited ban on the use of DEHP, but setting a migration limit for the most commonly used phthalate, DINP. The majority of EU Member States at the meeting (Germany, Spain, France, Italy, Austria, Sweden, Denmark and Greece) made it clear that they wanted a ban on the use of *all* phthalates in soft PVC toys and childcare articles and would not accept a migration-based approach.

On the 10th November 1999 the European Commission agreed on a proposal for both an emergency and a permanent ban of soft PVC teething toys intended to be put into the mouth for children under three years old. All toys that are not meant for teething but are likely to end up in a child's mouth would merely be labelled 'to be kept out of mouth', a measure which could take 3-4 years to take effect.

World-wide action

By the end of 1998 a host of toys companies had taken action to phase out phthalates in children's toys. The list includes: Chicco (also phasing out soft PVC for children under 3), Little Tikes (also phasing out soft PVC for direct to mouth products), Disney, Mattel (Fisher-Price ARCOTOYS, Tyco Preschool), Evenflo, Safety 1st, The First Years, Sassy (is also phasing out PVC in teething toys), Gerber, Shelcore Toys, Hasbro (including Playskool), Warner Brothers Studio Stores

Many major US retailers removed phthalate-containing teethers, rattles, pacifiers, and bottle nipples from store shelves: Toys-R-Us, Walmart, Sears, Target, K-Mart. On the 5th of January 1999 the Spanish company Play By Play Toys Novelties announce that they would stop making chewable soft PVC toys for children under three.

In April 1999 Bandai, Japan's largest toy producer (most famous for the Tamagocchi virtual pet) confirmed that they had already stopped the use of PVC in the manufacture of certain toys. Bandai recognised the environmental and public health effects not only of phthalates in PVC, but of PVC as a source of dioxin.

In June 1999 Tomy, the second largest toy producer in Japan confirmed that they had stopped the use of PVC in products that could be chewed for children under three years age. Tomy said that they have been researching into alternatives not only for soft PVC but also hard PVC (packaging materials).

In June 1999 the toy company First Years announced that they were labelling the packaging of a Winnie the Pooh teether with 'PVC Free: contains no polyvinyl chloride or phthalates.'

In September 1999 the Spanish company AMPA HISPANIA, S.A. announced that they intended to phase out PVC from all their products. This company supplies, among others, to one of the largest Department Stores in Spain 'El Coret Ingles'.

The final blow to PVC manufacturers was the announcement on December 9th 1999 by the world's biggest toy manufacturer, Mattel: they would not only stop using soft PVC for children's toys but also they would eliminate PVC from all its toys and, within two years, switch to using bio-plastics.

In the space of three short years the Greenpeace campaign warning the public about dangers of phthalates in children's toys made of soft-PVC had the result of not only stopping these toys being made with PVC but also the knock-on result of convincing major world companies to find alternatives for PVC. For example, several vehicle manufacturers have now stopped using PVC. In 1999 General Motors (GM) in the US, the world's largest car manufacturer decided to eliminate PVC from its auto interiors. GM said moving away from PVC will enable improvements in durability and a reduction of interior odours. General Motors was the first car company to make a public announcement of its intention to stop using vinyl in auto interiors, although other automakers have quietly been moving away from vinyl for several years. Honda recently announced its intention to create a 100% recyclable/PVC free auto by 2010, and Daimler Benz has not used PVC for interiors or under-coatings in Mercedes autos since 1995.

As Axel Singhofen, Greenpeace International Political Advisor in Brussels, observed, 'the General Motors statement is significant because it may signal a 'sea change' away from obsolete PVC plastics toward safer materials in the 21st century. GM is the first car company to break the code of silence surrounding PVC, which is good news for the environment and bad news for the PVC industry'.

Annex 3 Some companies developing bio-plastic materials or products

Company	Country	Material/Product	Bio-plastic material used
Novon http://www.ia-usa.org/a00-21.htm	Tonawanda, New York, US	Material Product: Packaging, composting, agricultural, food service and personal care.	Starch based - Corn and soya
Metabolix http://www.metabolix.com	Cambridge, Massachusetts US	Material PHA and PHA latexes.	PHA (polyhydroxy alkanoate)
BioPlastics A jv company EverCorn Inc., with major Japanese corn wet miller, Japan CornStarch. In conjunction with MSU	Denver Colorado, US	Material: Holds a patent for a thermoplastic Poly(caprolactone) with polystyrene like properties Product: Bodegradable/compostable bags for retail and lawn-leaf collection.	Poly (caprolactone) -starch resins based on sugars and agricultural fibres.
Biomer	Munich, Germany	Material : Since 1994 licensing all patents, strains, and know-how for the production of PHB with the strain A. latus from PCD Polymer.	PHB poly-hydroxy-butyrate
National Starch and Chemical Company (NSC)/ ICI http://www.nationalstarch.-com/	United Kingdom	Material	Compounds of adhesives based on corn, potato and tapioca starches
Cargill Dow Polymers LLC http://www.dow.com/plasti-cs/news/pn_cargill.html	Minneapolis, Minnesota, USA	Material	PLA resins
Novamont	Fertec/Novom-ont SPA, Novara, Italy	Products: Mater-Bi	Thermoplastic starch derived from corn, wheat and potato starch. Produced by blending starch with poly(e)caprolactone
BIOTEC (Research Organisation within the German Melitta group)	Germany	Products: BIOPLAST BIOFLEX BIOPUR	Based on thermoplastic starch using potato and other biodegradable ingredients
AVABE Started as a farmer's co-operation in 1919	Netherlands P.O. Box 15 9640 AA Veendam	Products: PARAGON speciality products for the food, pharma, paper, textile, adhesives and building industry	Based on thermoplastic starch mixing starches derived from potatoes with biodegradable additives.
Fardem (originally family owned company making jute bags)	Belgium	Products: Products include starch-based biopolymers. Organic waste bags, agricultural film, mailing films, carrier bags	Based on thermoplastic starch

Annex 4 Principles of clean production

Production processes and products designed with little concern for their environmental impacts frequently damage human health and that of our communities, and wreak havoc upon earth's fragile ecosystems. The resulting environmental degradation is global and all people are affected. But the burden of environmental degradation falls disproportionately on the poor, politically repressed, and people of colour.

To end and reverse these impacts requires a commitment to clean production. Achieving clean production requires the continuous application of prevention, democracy, precaution, producer responsibility for impacts caused by production processes and products, and consumer responsibility.

Principles

Preventive approach. Prevention means reducing the toxicity (detoxification) and material intensity (dematerialization) of products and production processes. Prevention in production processes is achieved through in-plant changes in processes, materials, and operations management. Implementing prevention techniques requires using less or non-toxic materials, renewable rather than non-renewable materials, and reducing energy and water use. Prevention in products is achieved - across their lifecycle – through changes in product design and end-of-life product management. Products designed using a preventive approach:

i) contain or use no persistent, bio-accumulative, carcinogenic, neurotoxic, teratogenic, or developmentally toxic chemicals or genetically modified organisms;

ii) are reused, recycled, or composted at the end of their lifecycle;

iii) are manufactured using the cleanest and safest materials and processes.

Preventive techniques do not shift risks between environmental media, workers, or citizens.

Right-to-Know. Citizens and workers have the right-to-know and understand the hazards and environmental impacts of materials used in manufacturing processes and contained in products and their packaging. This requires producers to report facility and product emissions and exposures as well as the use of all materials (including their hazards), energy, and water used in production to workers, citizens, and governments. Manufacturers should include on products a label that lists materials used in production, contained in the product, and used in its packaging (including their potential hazards).

Right-to-Participate in Decisions Affecting Public, Occupational, and Environmental Health. Citizens and workers have a fundamental right to participate in the decisions that affect their health, life, and environment. This includes a right to prior informed consent before exposure to potentially dangerous activities or products. Such participation can be achieved through an

open meeting process and the preparation of Environmental and Human Health Impact Statements prior to constructing or renovating production, recycling, and disposal facilities and producing or importing new products.

Precautionary approach. When an activity (or material) raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of the activity (or material), rather than the public, should bear the burden of proof (of proving safety or that no safer alternative for an activity or material was available).

The Responsibility of Producers.

Extended Producer Responsibility. Manufacturers should be responsible for the environmental and health impacts caused by their products and production processes throughout their lifecycles. Extended producer responsibility involves four forms of responsibility: physical responsibility, economic responsibility, product liability, and informative liability.

Physical responsibility means producers are held accountable for a product once a consumer finishes using it. The physical management of a product may entail collecting, processing, composting, treating, or disposing of products.

Economic responsibility means producers must pay for the physical management of a product after a consumer finishes using the product.

Product liability means producers take responsibility for environmental damages caused by a product during production, use or disposal.

Informative liability means producers must provide information on the materials used to produce and contained in a product and the environmental and human health effects of these materials throughout the product's life-cycle.

Citizen Responsibility to Sustainable Consumption.

Citizens, especially affluent ones, have a responsibility to consume in a way that is sustainable. This entails limiting consumption of short-lived, non-essential products; reducing the use of products that consume large amounts of resources or contain or use toxic substances in their production; increasing the use of durable, repairable, and less-toxic products; decreasing reliance on polluting forms of transportation; increasing 'sharing' of durable products; and reusing, composting, and recycling products at the end of their useful life.

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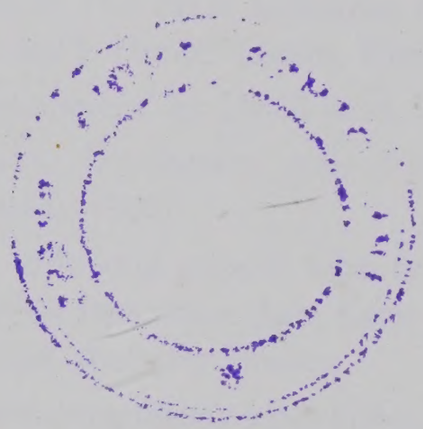

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